ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXIV. No. 44.

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THE BOLAN PASS RAILWAY, from India into Afghanistan, is an absolute failure, and, according to *The Indian Engineer*, the Indian authorities recommend a new route from the Gomal through Kujuri Kach and Apozai to Quetta. The government proposes to take up the road material and store it at the beginning of the new line; but they are not to build the line until it is "actually needed." Sir JAMES BROWNE, who has recently reconnoitred the whole route, strongly condemns this policy, says the material would be useless in a few years, that such a line as proposed would cost $40,000,000, and that it could not be completed in time for any emergency. He recommends the Gomal-Zhob route. Some one has evidently blundered on this far-away frontier of India and Afghanistan.

THE TRANS-CASPIAN RAILWAY PAYS. Instead of a deficit of 300,000 roubles ($180,000) in the working of the line in 1889, as expected, that year shows a net profit of 70,000 roubles, or $42,000. The importation of Asiatic products into Russia shows an increase of 127%, and of exports from Russia an increase of 94%. The prospects for 1890 are still more promising; the first six months have exceeded the income of the same period for 1889 by $300,000. *Indian Engineering* says there is little doubt that a second line will soon be built from Sanara to Tashkend.

THE JERUSALEM-JAFFA RAILWAY has just been equipped with three locomotives made at the Baldwin Works in Philadelphia. They arrived at Jaffa on Sept. 22. Thus the first locomotives used in this ancient land are made in the New World.

PASSENGER CARS OF AMERICAN PATTERN are to be put on all German government railways much used by tourists, says a dispatch from Berlin. The change is to be commenced next summer.

A NEW PASSENGER CAR has been invented by Mr. LESLIE P. FARMER, late General Passenger Agent, N. Y., Lake Erie & Western R.R., and now Passenger Commissioner of the Trunk Line Association. This car is entered through double doors at the center, with the door sill just above the level of the station platform and the steps wholly within the car. Doors for passage only are also provided at the ends of the car. The advantages claimed are that with the door closed it will be impossible to get on or off while the train is in motion; riding on platforms is impossible, as the cars are very closely coupled; the center steps are 4 ft. wide, and the car can be more easily emptied, passengers coming from both ends. Center doors also shut off the draft caused by the movement of conductors.

THE STREET RAILWAY SYSTEM OF THE CITY OF MEXICO, says Commissioner of Public Works LECHE, of New Orleans, is one of the best managed in the world. It was organized some years ago with a capital of $5,000,000, and is now paying a dividend of 6% per annum. The cars are built by the John Stevenson Co., of New York, and are hauled by mules. The cars are graded as to class. Yellow indicates first-class, fare 12 cts.; green, second class, with a slightly reduced fare, and blue, third class, fare 6 cts. to any part of the city. Smoking is permitted in every class of street car, as it is in fact everywhere in Mexico, excepting only in the churches, and in the Pullman sleepers on the railways.

THE WORST ACCIDENT OF THE WEEK was due to a derailment of a vestibule express on the Atchison Topeka & Santa Fe R. R. Oct. 24. About 150 persons were on the train, 23 of whom were injured, 8 fatally. The derailment was of the "unexplained" variety, accompanied by high speed on a sharp curve, but not apparently due thereto, since the speed was no higher than is customary. It is worthy of note that the Santa Fe has a peculiar theory and practice in regard to the fillet radius of wheel flanges, making them only ⅝ in. (*i. e.* making something like a sharp flanged wheel from the beginning), and an argument of no little strength can be made that this directly tends to cause "unexplained derailments." That this is true we will not assert, but the probability seems to us to be that it is.

AN IRON BRIDGE FELL on the Illinois Central R. R. Oct. 25, near Dubuque, Ia., due to a derailment caused by a broken truck of the eleventh car of a freight train. The preceding cars and engine went over safely. The bridge floor appears from the accounts to have gone to pieces at once, being disturbed because of repairs. Fifty men were at work on the structure, one of whom was killed and 5 injured. The false works for the iron swing bridge across the Nooksack River were carried away by a flood Oct. 22. The bridge is on the line of the Fairhaven & Southern R. R., from Fairhaven to New Westminster, B. C., about 12 miles north of Fairhaven. Piles for the pier protection had been driven, but a rise in the river brought down about 15,000,000 ft. of logs, mixed with a large amount of driftwood. The pier protection held till the jam formed up the river 1,600 ft. The river was rising rapidly, and finally carried the jam down against the false works. Credible reports say that a bridge (truss span) on the Bellingham Bay & British Columbia R. R., on the same river, went out also. A wagon bridge is reported damaged. A 75 ft. span wooden highway bridge near Tomhannock, N. Y., fell Oct. 25. The bridge was quite a new one, and will be replaced by an iron bridge.

A NEW STANDPIPE AT TEMPLE, TEX., failed early in the morning of Oct. 25. It was of steel, 20 ft. in diameter by 120 ft. in height, and had but recently been completed and filled. The press dispatches state that the lower sections of the pipe were thrown to one side badly out of shape, while 16 sections, higher up, thrown in another direction, remained intact. The stone foundation was but slightly damaged. The cause of the failure has not thus far been satisfactorily accounted for, as no flaws, at the time of the latest reports, had been discovered in the material. The contractors for the structure were Thomas & Gorman, of Houston, and the material was from Ripley & Bronson, of St. Louis, Mo. W. D. PENCE, C. E., of Temple, informs us that the pipe had not been formally received by the water-works company. Several buildings near the structure were damaged, and one house was crushed, took fire from a lamp and was burned, seriously injuring O. T. RIGDON.

A DIVIDED STEEL STEAMER, the *Mackinaw*, of 2,578 tons, has been sent down the canals to Montreal, to be reconstructed there previous to her shipment to New York. The *Mackinaw* was built at West Bay City, Mich., was taken to the dry-dock in Buffalo, N. Y., and there cut in two to enable her to pass through the St. Lawrence canals, and she was passed through about forty-two canal locks in eleven days. This is the first steamer built in the Lakes and thus transferred to the transatlantic trade.

COMPOUND ARMOR TESTS, at Amager, near Copenhagen, fully corroborate the results of the recent trial at Annapolis. The Cammell compound plates were found to be much inferior in resisting power to the Creusot steel plates. No nickel-steel plates were tested.

THE FIRST TWO 10-INCH GUNS, completed for service in this country, were mounted in the turrets of the monitor *Miantonomah* this week at the Brooklyn Navy Yard.

A NOVEL DEVICE FOR GREAT GUNS is invented by Mr. LOUIS GATHMAN, of Chicago. Assuming that the rapid heating of the interior shell, with the outer shell still comparatively cool, is the chief cause of the bursting of great guns, Mr. GATHMAN proposes to cool the gun after each discharge by releasing capsules of liquified carbonic acid gas placed in the rear of the powder discharge. He also claims that an application of the same capsules, used in connection with a peculiar arrangement of the powder chamber, by which it is much contracted in area at the front end, can be utilized in discharging high explosives. His theory is that the released gas goes out between the projectile and the bore and keeps the former from heating. He is said to have fired charges of dynamite in this way, but no authentic reports of the trial are attainable, and the whole scheme seems almost absurdly impossible.

THE PRINCE EDWARD ISLAND TUNNEL PROJECT is revived by the success of the St. Clair tunnel. The Dominion Government has been asked to assist in Senator HOWLAND'S scheme, for which the preliminary surveys have all been made. There is said to be no great engineering difficulties in the way; but at the nearest points between Prince Edward Island and the main land a tunnel 6¼ miles long would be required, and the estimated cost is $17,000,000. An English syndicate has offered to build the tunnel if the Canadian Government will guarantee 6% interest on the bonds for 100 years.

THE SURAM PASS TUNNEL, on the Batoum-Baku railway, was formally opened on Sept. 28. The work was commenced in 1886 to avoid the steep grades of the Suram Pass line, and about 2,000 Italians, Greeks, Persians and Turks have been employed continously since then.

THE NICARAGUA CANAL CO., says Gen. DANIEL MCAULEY, has expended, so far $3,000,000 on the work done and is making substantial progress.

THE ONEGA-WHITE SEA CANAL has been surveyed by Russian engineers during the past autumn. Lake Onega lies about 200 miles north-east of St. Petersburg, with Lake Ladoga between. The surveys show the water in the White Sea to be 15 ft. higher than that of Lake Onega. The length of the proposed canal would be about 131 miles, of which 75 miles are a natural waterway. The proposed canal would be 63 ft. wide, and at locks 112 ft. wide. It would be 10 ft. deep. The estimated cost is $5,000,000, not including the cost of a port at the White Sea end. This canal would cheapen and facilitate the transport, to St. Petersburg, of fish and also of ores from Olonets. The strategical importance of connecting Cronstadt with the White Sea is not the least consideration, as ship-building can be carried on on a large scale with the unlimited timber supply of Olonets.

FOURTEEN "PROMINENT" SEWER CONTRACTORS, of Buffalo, N. Y., were indicted by the Grand Jury of that city this week for an alleged conspiracy cheat and defraud the city by a secret combination on bids for the Seneca and Michigan street sewer. The amount involved was only $5,000, though the Grand Jury say that $3,000 would have built the sewer. The contractors claim, on the other hand, that $5,000 is not excessive, as there is much quicksand to be handled.

The Zumpango Tunnel Works.

The works now under course of construction for the drainage of the valley of Mexico consist, first of a canal and secondly of a tunnel, called respectively in its northern and southern divisions the Tequixquiac and the Zumpango tunnel. The canal starts from Lake Texcoco, on which is situated the city of Mexico. It runs 41 kilos. (25.42 miles), almost due north, connecting there with the southern end of the Zumpango tunnel. The Zumpango tunnel again runs almost due north for 6,200 m., where it joins the Tequixquiac tunnel, and continues in the same direction 9,521 m. more, where the Tequixquiac tunnel discharges into the valley of the village of Tequixquiac, whence it takes its name. It will thus be seen that the distance from the north end of the tunnel to the south end of the canal is 56,721 m. (about 35¼ miles), while the total length of the tunnel is 15,721 m. (9.76 miles), making it up to date the longest tunnel in the world, the new Croton Aqueduct tunnel (30 miles) alone excepted. The St. Gothard tunnel is 9¼ miles; the Arlberg is only 6¼ miles.

As most of our readers know, and as we have often before explained, the City of Mexico is situated in a large valley or basin through which the canal now in course of construction runs. Several attempts have heretofore been made to drain this valley, in which the city is situated, all of which have been futile, commencing with the attempt made by the Spaniards, which included the great Nochistongo cut, which we have already illustrated and described (ENG. NEWS, April 5, 1890).

The great difficulty of draining this valley or basin arises from the fact that, owing to the low situation of the valley compared with the surrounding country, it is very hard to find a location in which can be obtained enough fall to carry away the water. As will be observed from the section, the gradient of this tunnel, 1 in 1,388.9 or 0.072 per cent., is very light, taking into consideration the cross-section. The cross-section was designed by Mexican engineers for the Mexican government.

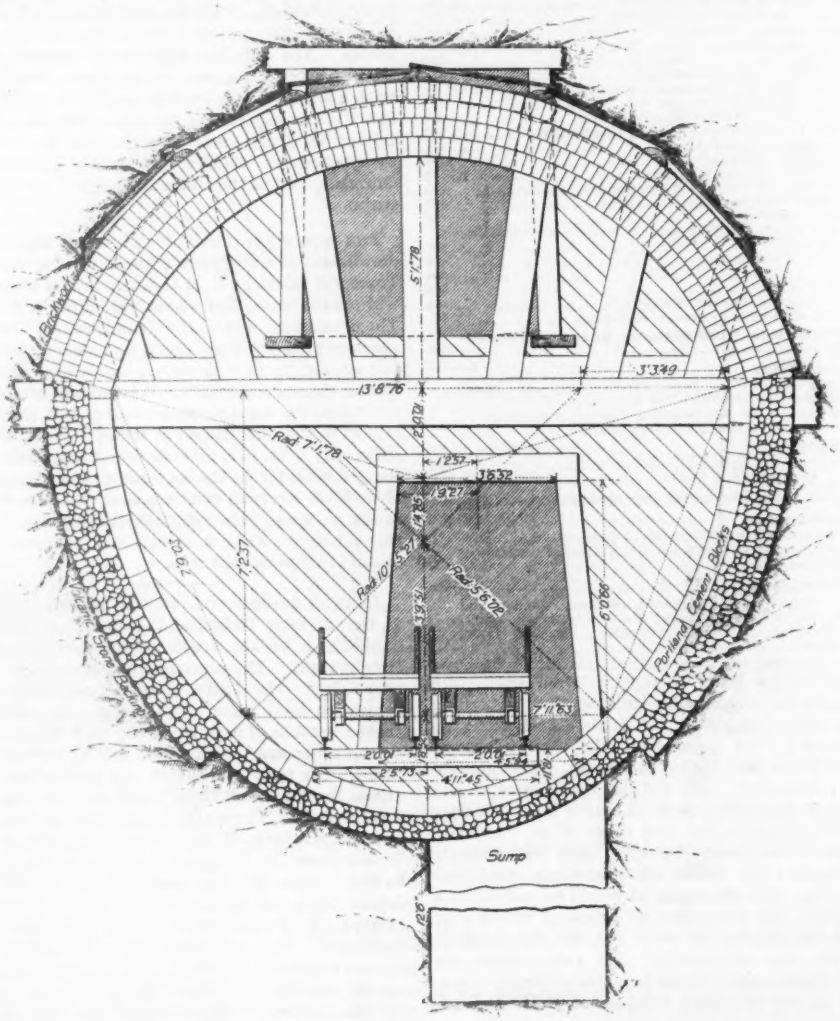
The Tequixquiac tunnel was commenced during the Empire of Maximilian, and was operated by the Mexican government at different times up to 1888, when it was taken up by Messrs. Read and Campbell, the present contractors. Its status, when work on it was resumed, with a profile of the tunnel, was shown in our issue of Aug. 10, 1889. The original idea was only to construct the Tequixquiac tunnel, prolonging the canal to meet it, but the Mexican engineers finally concluded that it was preferable and more economical to lengthen the tunnel south by 6,200 m., substituting it for the same length of canal. This decision was finally consummated in October of last year, when the contract for the Zumpango tunnel was obtained by Messrs. Read and Campbell.

The alignment of the Zumpango tunnel is one continuous tangent. The engineers of the Mexican government are responsible for maintaining this alignment, and for this purpose have placed on the surface along the whole line of the tunnel stone monuments at intervals of 400 m., which serve the purpose of bench marks and points on tangent.

At the south end, where the Zumpango tunnel joins the canal, the depth to the soffit of the tunnel arch is about 19 m. from ground level, and runs up to an average of about 20 m. through the Zumpango tunnel. On the Tequixquiac tunnel the average depth is greater, shaft No. 17 being 93.28 m. above the soffit of the arch. In the Zumpango tunnel the ground is fairly level, one-third of the tunnel running under the shallow lake of Zumpango, from which the tunnel takes its name. At the commencement of the Tequixquiac tunnel the ground begins to rise, and increases until it attains a maximum depth of 93 m. at shaft No. 17, when it commences to slope rather abruptly down to the valley of Tequixquiac, where the tunnel opens directly into a heavy cutting, which discharges into the valley. Both tunnels are being operated by shafts sunk at intervals of 400 m. all the way along the line. In the Zumpango tunnel there are 15 of these shafts, while in the Tequixquiac end there are 24.

Up to date (Oct. 14) there are 3,800 m. of tunnel completed in the Tequixquiac tunnel, while in the Zumpango tunnel there are four shafts completed, with a show of about 60 m. done; and on an average the other 11 shafts are about three-quarters of the way down to the tunnel.

The average progress is from 15 to 20 m. of tunnel excavated and lined to each face per month when the shaft is once in fair running order. The ground in the Zumpango tunnel is good as yet, being the kind of hard volcanic mud locally called *tepetate*, which covers the greater portion of the surface or sub surface of Mexico, often extending to a great depth. The nature of this peculiar material we have often explained. It cuts like a half-baked clay, and holds a slope like rock. The ground does not require very much timbering, the chief obstacle being water. Of course, it does not at all follow that the ground will continue throughout of the same nature as at present encountered, as, in sinking the shafts, a great deal of quicksand has been met with; and in the other tunnel (Tequixquiac) some very heavy ground has been encountered. The water, however, is a very serious difficulty, and one



SECTION OF ZUMPANGO TUNNEL, SHOWING HEADINGS, ARRANGEMENT OF CAR TRACK, ETC.

that has caused, and is causing, great expense and trouble. In one of the shafts, during the process of sinking, a Knowles and a Cameron pump were working and discharging together 350 galls. per minute and were unable to lower the water. At the present time, while working in shaft No. 4 (Zumpango tunnel) excavating the invert of the tunnel, a vein of artesian water has been struck, which alone discharges some 150 galls. per minute, and the expectation is that, when well underway in the tunnel, the pump will have to dispose of 500 to 700 galls. per minute in each shaft.

The shafts are sunk with Tangye, Knowles and Cameron steam pumps, being lined with brick as they are sunk. The lining has had to be slung during the process of sinking in several cases, owing to the prevalence of quicksand. The quicksand seems to run in a vein, and averages from 6 to 12 ft. in depth, bringing a lot of water with it. One section of the tunnel, 5 to 6 m. long, is got in below the shaft before removing the steam pumps in order to support the weight of a 16 in. Cornish pump averaging 3 to 5 ft. stroke, which is then installed. Up to date it has been during the sinking of shafts that the greatest difficulties have been met with, as the steam pumps are liable to all sorts of break downs owing to sand and mud in the valves, etc.

Messrs. Read & Campbell are compelled for the present to use English or American supervision almost altogether in work both above and below ground, as most of the work is of a new special nature in this country. Two English miners are at present necessary in each pit to attend to timbering, etc., the system of which the natives are at present learning, and there has been also up to date an English mason to superintend the lining.

All brick, lime, etc., are manufactured on the ground; also the cement blocks with which the sides and invert of the tunnel are lined. There is a species of lava here locally called *tezontle*, which, when ground to a powder and mixed with lime and sand as mortar, has strong cohesive powers and is highly hydraulic. This compound is used in the lining of the tunnel. The backing of the tunnel is also composed of volcanic stone, which is immensely hard and heavy, and forms a very good material for rough masonry, with the exception that the stones are generally rounded very much by friction, and for work such as engine beds, etc., it is hard to get a good bond. As the country around is all of volcanic formation, the reason for using the materials will very readily be seen.

A narrow-gauge railway, built by the contractors, runs the whole length of the tunnel, on which are constantly employed 4 locomotives and 70 cars, taking material to the different shafts.

There are at present employed on the two tunnels 55 engines averaging 20 HP., running pumps, mortar-mills, brick machines, etc.

The average consumption of coal is about 20 tons per day of 24 hours, and of wood about 50 cords. There are three large brick yards with an average

output in each of 25,000 brick per day. There are also two lime kilns and a large cement block factory with an output of 5,000 per day.

Messrs. Read & Campbell expect to complete their contract about the end of July, 1892.

We furnish herewith a section of the tunnel, showing quantities, construction, etc., and the system of timbering at present in use on the Zumpango tunnel, but the timbering thus shown is suitable for good ground only. The bottom-heading shown in the plan is driven for the purposes of drainage from one shaft to another, as the arrangement is to locate pumps in every alternate shaft, running the bottom-headings through to the intermediate shafts, thus enabling the intermediate shaft to be sunk without pumping. The water in them, as may be readily seen, runs through into the bottom-heading.

The top-heading is merely driven far enough, as the work progresses, to enable the bars shown in the plan to be drawn forward as the brick work in the arch surrounding them is completed. It may also be noted that the bars are not left in the brick work as in vogue under some systems.

The Chief Engineer of the work is Mr. Fred. W. Abbot, and to him we are indebted for the accompanying drawing, and the information on which this article is based. The main dimensions of the tunnel are:

	Sq. m.
Area of arch	3.12
" sides	0.74
" invert	0.42
" backing	2.05
" opening	13.69
Total	20.02

The calculated velocity is 4.96 ft. per second; wetted perimeter, 24.75 ft.; dry perimeter, 18.39 ft.; calculated discharge, 292,492 galls., or 28,370 cu. ft. per minute.

The bricks used are very large, about 9.8×4.7×2.4 ins., laid with an 0.4 in. joint. The Portland cement blocks are about 16×8×6 ins. It should be explained also that owing to the nature of the material no great pressure is to be expected on the arch, which is mainly necessary to keep the *tepetate* from weathering and splitting off in detail.

In ENGINEERING NEWS of Aug. 10, 1889, we gave a plan of the Mexican valley and longitudinal section of the Tequixquiac tunnel, as well as a full description of the geological formations of the locality. In our issues of April 5 and 12, 1890, appeared a complete account of the water supply of the valley and a cut of the Nochistongo Cut, begun in 1607 by the Spaniards, and completed in 11 months, a remarkable piece of work when the difficulties of construction are taken into account.

The Suction and Siphon Pipe of the Auburn, N. Y., Water-Works.

The Auburn Water-Works Co. built works in 1865 for the public water supply of Auburn, N. Y., taking their supply from Owasco Lake, from an impounding reservoir formed by a dam across the outlet of the lake. In 1883 a 24-in. suction pipe, 9,500 feet long, was laid from the lake to the pumps. The pipe was laid to conform to the natural surface of the ground, instead of to a hydraulic grade. As will be seen by examining the accompanying profile, Fig. 1, the natural surface is quite uneven, especially at some distance from the lake, where the pipe rises about 18 ft. above low water, after which it descends rapidly and passes under a stream just before reaching the main pumps.

The pipe is operated as a siphon, there being an 8,000,000-gall. Gaskill pump at the lake end, for use in case of emergency, and at the other end a 6,000,000-gall. Holly quadruplex water-power, with a Holly engine in reserve, and one 8,000,000 Gaskill horizontal pumping engine. One of the pumps (probably the water power) is 5 ft. below the low water mark, and has a pressure from the pipe varying from 2 to 5 lbs. The other pumps are 10 ft. above low water, and from 5 to 6 ft. above high water in the lake, and have a lift of 10 ft., as shown by the vacuum gauge.

When the pipe line was completed and ready for use the Superintendent, Mr. NELSON B. ELDRED, to whom we are indebted for these data, states that he filled the main with water, driving the air out at the high points, and then allowed the pumps at the main station to draw from the pipe until the air began to come. The gate at the lake pump-house was then closed and the pipe filled through a meter at the upper end. By this process it was found that only about 15,000 galls. were required to fill the pipe, from which Mr. ELDRED concluded that the highest points had become filled with air. Two large bilge pumps were afterward attached to the two highest points and operated as soon as the main pumps were again started, in order to keep the pipe at these points full of water. The pipe was then opened at several other high points, and the operations of the whole line watched. The final conclusion was that by laying a small line of pipe parallel to the main, and connecting it to an air pump and to the large pipe at the highest points, the pumping main could be operated under any condition, provided the air was exhausted through the small air pipe.

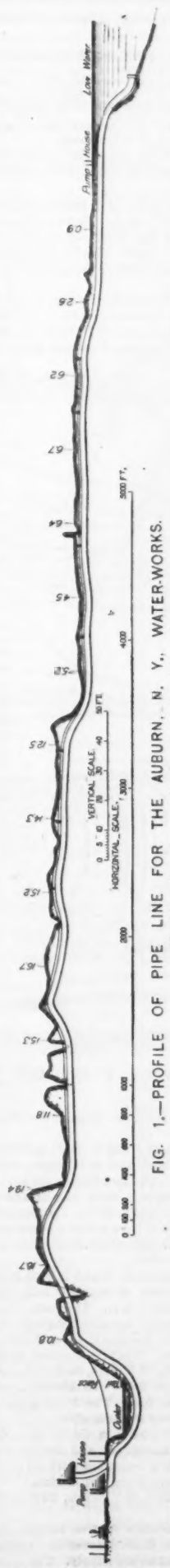


FIG. 1.—PROFILE OF PIPE LINE FOR THE AUBURN, N. Y., WATER-WORKS.
The black line above main pipe shows the siphon pipe.

The location of the air pump is shown on the profile, as are the connections of the two pipes, now 10 in number. The air pump is worked with a vacuum of 20 to 27 ins.

As now operated this line was put in use in the summer of 1885. During 1886, when the water became warm and the ground dry there was some difficulty with the air, but in the late fall, when the ground became wet, the trouble perceptibly decreased. This led Mr. ELDRED to believe that there was leakage of air through the lead joints of the pipe, and in 1887 each joint was uncovered, recaulked and pointed with red lead.

From October, 1886, to July, 1890, Mr. ELDRED states there was no interruption in the flow of the water, even when the pumpage was quickly doubled. But if the air pump was stopped the flow of water gradually decreased, and in two or three hours was entirely cut off.

In 1890 the air pipe was carried back 3,500 ft. further than it originally extended, owing to the fact that some air accumulated in the main beyond the air pipe, temporarily checking the flow when the pumpage was increased rapidly. This extension had the desired effect.

The air pipe is 3 ins. in diameter back to the second connection, or for 1,500 ft., then 2½ ins. to the third connection, 1,500 ft. farther, and from that point to the end of the original line, 1,300 ft., it is 2 ins. in diameter. The size of the late extension is 1½ ins., and its length is 3,500 ft., making the total length of the air pipe 7,800 ft. Each of the connections between the two pipes is 2 ins. in diameter, and each is provided with a valve, as shown in Fig. 2, for regulating the size of the opening between the two pipes, according to the amount of air to be removed from the syphon.

The original plan provided for traps at the lowest points on the air pipe, from which water drawn into the pipe, could be removed. These traps have proved to be unnecessary, for while some water enters the air pipe, the amount is not large enough to give any trouble.

Thinking the method described above capable of a somewhat general application Mr. ELDRED has patented it, claiming for the invention what it has already practically done, and its applicability to other liquids than water and other gases than air, and also—and principally, perhaps—that by its use the necessity and cost of laying pipe lines to a uniform grade may be avoided.

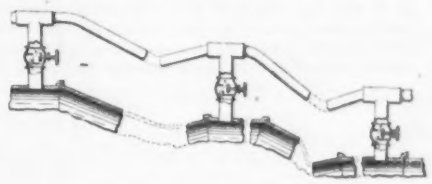


FIG. 2.—Valves for Siphon Pipe.

The adoption of such a method in connection with a new pipe line would involve the question which, in the long run, will be the cheaper, laying the pipe to a uniform grade, or to a natural grade, and, in addition, establishing an air pumping plant and an independent air pipe line, connecting with the highest points of the main pipe?

Mr. ELDRED assures us that at Auburn the method adopted was much the cheaper, the nature of the trenching being difficult and expensive, and the total cost of the air plant and the expense of operating it both being small.

The Edgar Thomson Steel Works and Blast Furnaces.

From a recent publication prepared for the benefit of the visiting iron and steel men of England and Germany we abstract the following concise description of these great works, which we somewhat condense:

The Edgar Thomson Steel Works and Blast Furnaces are situated 11 miles east of Pittsburg, Pa., at Bessemer, a station on the main line of the Pennsylvania R. R. which is on the north side of the works. The Baltimore & Ohio R. R. runs throughout the entire length of the plant and forms a line separating the blast furnaces from the steel making and rolling department. The Pittsburg & Lake Erie R. R. is on the south side of the works. On the east side is Turtle Creek, a small stream emptying into the Monongahela River, which is on the south side and on which the company's property has a wharfage of 3,000 ft. The Monongahela River furnishes a constant water supply and gives facilities of water carriage over the whole Ohio and Mississippi system of navigation, while the three railroads transport material to and from the works in all directions. The area occupied is 160 acres, 15 acres being covered by buildings.

The compensation of workmen is regulated by a sliding scale of wages, based on the average price received for rails during the preceding month. The prices range from $26 to $48 per ton of rails, a printed scale showing the amount to be paid each class of workmen, according to the price of rails as indicated. The scale moves on a 50 cent fluctuation. This has been in practical operation for the past three years, and appears to be satisfactory to both employé and employer. The number of employés is about 3,500, representing a population of 10,000 people.

The plant is designed and arranged specially for the manufacture of Bessemer steel rails, the melted pig iron from the blast furnaces being converted into steel *direct*, instead of casting it and remelting in cupolas. The output per day of finished rails is sufficient to lay 10 miles of single track road with rails weighing 68 lbs. per yd When the nine blast furnaces are all in blast the daily production of metals is 20,000 tons. The production recently has averaged about 1,550 tons of metal per day The greatest output of any one blast furnace has been as follows: Per day, 457 tons; per week, 2,402 tons; per

month, 10,604 tons. The output of finished rails has averaged, recently, 1,075 tons, the best record being 1,417 tons per day; 7,222 tons per week, and 30,005 tons for the month. The aver ge outputs stated above require the handling daily of 10,000 tons of materials.

The general arrangement of the plant can be seen by reference to the letters and numbered plan shown. There are nine blast furnaces south of the Baltimore & Ohio R. R., designated as *A*, *B*, *C*, *D*, *E*, *F*, *G*, *H* and *I*, respectively. The stacks *A* to *G*, inclusive, are built in a row facing the river, while *H* and *I* are at right angles, for convenience of stock-yards.

At the southeast corner are the metal mixers (No. 12), to which the molten metal from furnaces is conveyed, and from which it is in turn taken over the "direct process track" to the converting works (No. 20), at the northeast corner. West of the converting works are the blooming mill (No 30), old rail mill (No. 28), and new rail mill (No. 31 to No. 38). North of the converting works are the shops, offices, etc. The water supply is taken from the Monongahela River by pumps located at different points and all connected to form one system. The main pump-house-, 56 × 130 ft., 49 × 54 ft. and 64 × 100 ft., containing the following boilers:

8 Boilers, 54½ ft. long, 50 ins. diam. Sub-boilers, 43½ ft. long, 40 ins. diam.	4 Boilers, 55 ft. long, 36 ins. diam. Sub-boilers, 46½ ft. long, 28 ins. diam.
8 Boilers, 42 ft. long, 48 ins. diam. Sub-boilers, 21 ft. long, 36 ins. diam.	12 Boilers, 55 ft. long, 42 ins. diam. Sub-boilers, 46½ ft. long, 32 ins. diam.

In addition to the above, there are under construction 8 new boilers, 23 ft. long, 54 ins. diameter, with two flues, 18 ins. diameter.

The second set of furnaces is *D* and *E*, built in 1881, each 23 ft. diameter of bosh and 80 ft. high. There are 6 stoves, each 78 ft. 6 in. × 21 ft., and one Whitwell stove. 78 × 20 ft. The cast houses are 54 × 180 ft. Blast is furnished by 7 engines, each 25-in. diameter steam cylinder, 84 in. air cylinders, and 48-in. stroke.

Steam is supplied from two boiler houses, 72 × 174 ft. and 76 × 146 ft., containing 20 boilers, each 55 ft. long, 50 ins. diameter, with sub-boilers, each 44 ft. long and 44 ins. diameter. In addition to the above, there are under construction 16 boilers, 54 ins. × 28 ft., two flues, 18 ins. diameter.

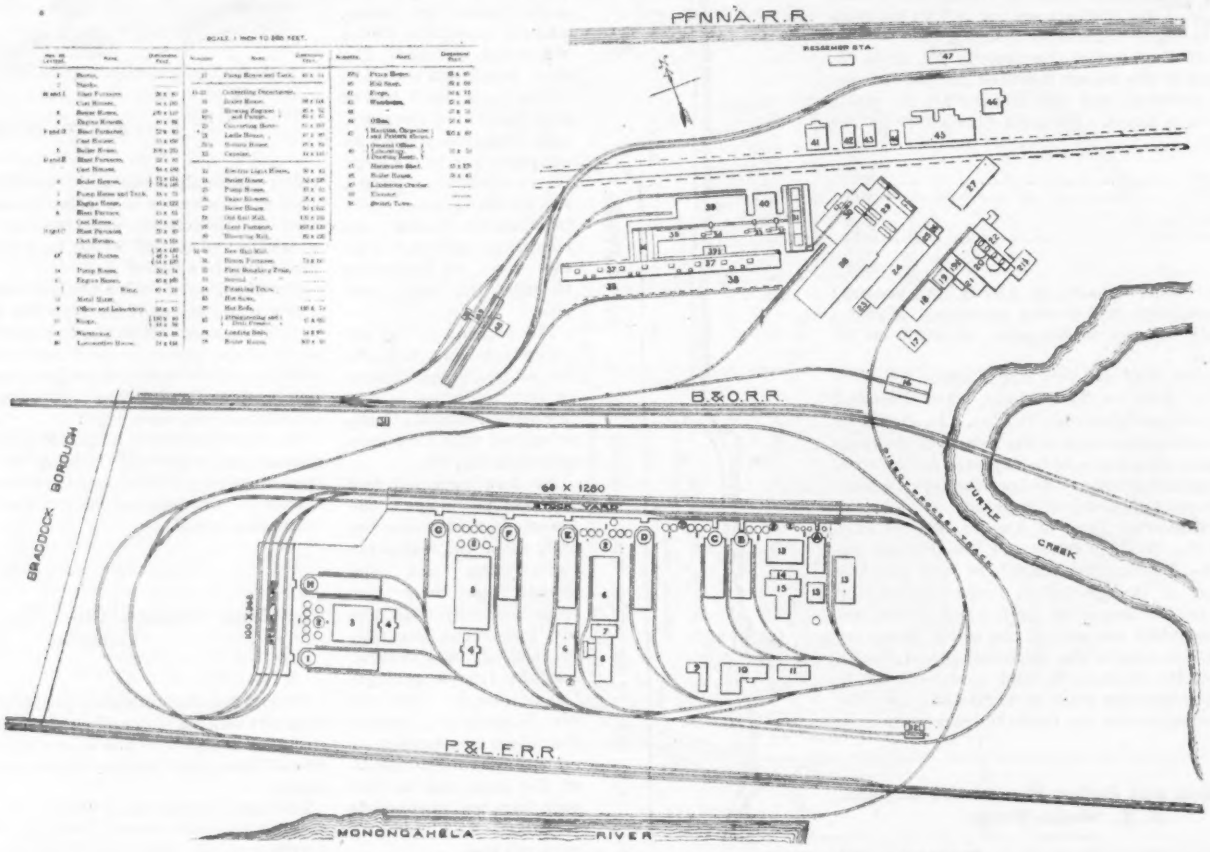
The third set of furnaces is *F* and *G*, built in 1886 and 1887, each 22 ft. diameter of bosh and 80 ft. high. These have 7 stoves, 78½ ft. × 21 ft. The cast houses are 55 × 160 ft. There are five blowing engines, each having a steam cylinder 40 ins. diameter, air cylinder 84 ins. diameter, and 60-in. stroke. Steam is supplied from a boiler house 100 × 200 ft., having 40 boilers, 28 ft. long, 54 ins. diameter, with two 18-in. flues.

The fourth set of blast furnaces is *H* and *I*, built in 1889 and 189', and each 22 ft. diameter of bosh and 90 ft. high. These have 7 stoves, each 78½ × 21 ft. The cast houses are 54 × 180 ft. The engine house contains 5 engines, each having a steam cylinder 40 ins diameter, air cylinders 84 ins. diameter, a 60-in. stroke. Steam is supplied from a boiler house 100 × 110 ft., having 24 boilers, each 28 ft. long, 54 ins diameter, with two 18-in. flues. In addition, there will be 16 boilers of the same size. The *F* and *G* and *H* and *I* batteries are connected by a steam pipe.

On the west side of the works is a Gates mastodon crusher, used for crushing limestone, and having a capacity of 800 tons per day. It is equipped with an elevator, for loading, with a Porter Hamilton engine, 14 × 18 ins., and with four steam boilers, 28 × 50 ins., having two flues, 14 ins diameter.

The metal-mixing plant consists of two mixers, two platform weighing scales, two double reversing engines 12 × 30 ins., and two boilers for steam supply. The mixer itself is a huge iron box, heavily lined with fire brick, mounted on a shaft turned by an engine, and has a nominal capacity of 100 tons. Actually, about 80 tons only are in the mixer at any one time. At the rear end, on top, is a hopper, into which the metal is run from a ladle on the overhead track. Below, and in front of the mixer, is another railroad track, with a platform weighing scale for each mixer. The empty ladle is run on this scale, weighed and half filled with molten metal from the tapping door, as the mixer is turned down. The ladle then goes to the next mixer, is filled and weighed. By the use of the metal mixers a constantly uniform grade of Bessemer iron is furnished the converting department.

The blast furnace department has its own office and laboratory buildings, shops, metal house, brick sheds skull-crackers, etc.



PLAN OF THE EDGAR THOMSON STEEL WORKS AND BLAST FURNACES.

THE STEEL DEPARTMENT.

From the metal mixers the molten metal is carried over an elevated standard-gauge track to the converting works, where it is at once tapped into one of the four 10-ton vessels, and converted into steel by the usual Bessemer practice.

The converting house is 86 × 165 ft., and contains four 10-ton vessels, two 10-ton hydraulic ladle cranes, 4 hydraulic ingot cranes, and one dumping crane. Two tracks pass through the building in front of the two casting pits. The ladle house is in a wing 46 × 80 ft., in front of the pits, and the ladles are swung by the ingot crane to the front of the ladle house, where they are taken up by another hydraulic crane. The bottom house is on the east side, in a wing 43 × 80 ft., and bottoms are run into it on cars and handled by a hydraulic crane.

There are five cupolas back of the converters in another wing 44 × 110 ft. These are not used since the introduction of the direct process.

The blowing machinery consists of three vertical engines with steam cylinders 42-in. diameter, 48-in. stroke, and air cylinders 54-in. diameter; one vertical double engine, with steam cylinder 36-in. diameter, 54-in. stroke, and 54-in. air cylinder; four No. 7 Baker blowers.

The steel is cast in moulds 7 ft. long, 15⅝ × 17½ ins. at top, 18⅝ × 20½ ins. at bottom. The moulds are not stripped from ingots in the pit, but ingot and mould raised by a crane from the pit, placed on a car and removed outside to the hydraulic pushers, of which there are two.

The ingot pusher is a hydraulic cylinder mounted horizontally on a frame and provided with water supply pipe and valves to control its action. In front of the cylinder is an upright frame, connected with the cylinder-supporting frame by heavy brace rods. The ingot and mould on the car are moved between the cylinder and the frame, the mould bearing against the frame; the piston is started and pushes the ingot through the frame on to another car, by which it is conveyed to the ingot furnaces.

Nine ingot furnaces are arranged in three parallel lines a car track running in front of each line. Four of these

ing stations are Nos. 7, 14, 17, 19½ and 39½. The estimated consumption is 25,000,000 galls. per day.

THE BLAST FURNACE DEPARTMENT.

The blast furnace department is operated as 4 independent plants, *A*, *B* and *C* constituting one, there being two furnaces in each of the others. Furnace *A* is used for the production of spiegel and ferro-manganese; the others for Bessemer metal.

Lake Superior ores are used. The coke is from the Connellsville region. The stockyards are 1,280 × 60 ft. and 368 × 100 ft. The coke is placed under roof; the limestone and ore exposed to the weather. During the week the furnaces are tapped into ladles, each of a capacity of 12 tons; on Sunday the metal is cast in chills.

All furnaces have Siemens-Cowper-Cochrane stoves, except where otherwise noted. Each set of furnaces has its own engines and boilers, and while all the boilers are connected, yet each engine house is practically dependent on its own boilers for steam supply. Each furnace is supplied with a double cage hoist operated by a 9 × 10-in. engine.

Furnace *A* was built in 1879, is 15 ins. diameter of bosh and 65 ft. high. It is equipped with four stoves, each 65 × 15 ft. The *A* cast house is 50 × 98 ft. Furnaces *B* and *C* were built in 1880, are each 20 ft. diameter of bosh and 80 ft. high. They have 8 stoves, 6 of which are 75 × 20 ft., and 2, 75 × 21 ft. These three furnaces are provided with 6 blowing engines, 6 of which are 35-in. steam cylinders, 84-in. air cylinders and 48-in. stroke; 2 are 32-in. diameter steam cylinders, 84 in. air cylinders and 48-in. stroke; the ninth has a 40-in. steam cylinder, 84 in. air cylinder and 60-in. stroke. Steam is furnished from three boiler

furnaces have 4 charging doors each, and five of them have 5 charging doors. These furnaces use natural gas. They are charged and drawn by ingot charges, of which there are three. The charger is a large six-wheeled truck, running on rails and carrying boiler, engines and driving machinery, by which it can be propelled in front of a furnace, a tongs, moved forward, grasping the ingot, lifting it and projecting it into the furnace. Each charger is operated by two boys.

After reheating, the ingot is taken on a car to the three-high 36-in. blooming train, which is operated by an engine with 36-in. cylinder and 72-in. stroke. The tables are operated by an independent double 9 × 12-in. engine. The bloom runs on tables and driven rollers to the shear and is cut into lengths. The shear engine is 14 × 24-ins. Near the shear is a three-ton hammer, and, if required, the blooms can be swung under the hammer by a crane and the necessary chipping done.

South of the blooming mill is the old rail mill, not in use at present. It is a three-high 23-in. roll train, provided with hydraulic and automatic appliances for rolling. Power is furnished by a 46 × 48 in. engine. The rails are cut to length by hot saws, operated by a 14 × 24-in engine. The rails are placed on hot beds by pushers driven by two engines, 9 × 12 ins. This mill has four straightening presses and four drill presses, operated by an engine 18 × 24 ins. In the rail mill annex are one straightening press, two drill presses, and a 12 × 20-in. engine for operating them. There are also two cold saws, operated by engines 11 × 20-ins.

At present, the old mill not being in use, after passing the chipping hammer, the blooms are delivered on a series of driven rollers, arranged on a curve, to the switch. The duty of this switch is to distribute the blooms to a car running on a track back of a long line of reheating furnaces, of which there are five, each having nine working doors. By an endless iron rope wound on a drum, driven by a special engine, the car may be moved in front of any particular door of the series. Each furnace has a charger or pusher which pushes the bloom from the car into the furnaces. In front of the furnaces is a somewhat similar apparatus for drawing the heated blooms. A special engine runs an endless wire rope, to which is attached a car. Upon the latter the drawing apparatus, with an ingenious grip, deposits the bloom, the car is run to driven rollers, which carry the bloom to the table of the first roughing train.

In the new mill, the ordinary three-high rail train is divided into three trains, the first five passes being made in one three-high 24-in. train, the second five in a second three-high 24-in. train, to which the first delivers directly and the last finishing pass in a two-high train of 24-in. rolls. Each train is run by its own independent engine, the first and second being 46 × 60 ins. and the 30 × 48 ins. The mill is nearly automatic, one man handling the levers which lift the tables, move the tumblers, etc. Each roll train has a hydraulic crane for changing rolls, which is done very quickly.

From the tables of the first train the billet goes to the second; from there, by driven rollers, to the finishing train. From the finishing train the rail is carried on driven rollers to the hot saws, where a three length rail can be cut into lengths by the four revolving saws. The hot saws are operated by an engine 16 × 21 ins.

The rails cut to length travel on another set of driven rollers, and are placed on two hot beds by pushers, driven by winding cables moved by special engines. The two hot beds are 4 ft. above the floor, and each is composed of 10 parallel rails, covering an area of 30 × 90 ft. The hot bed wing is 110 × 78 ft., and connects the mill to the finishing department.

From the bloom furnaces to the hot beds the three trains of rolls, tables and hot saws are all in one long, straight building, 520 × 60 ft., the hot beds being in a wing at right angles to this. After the rails have passed over the hot beds they reach the straightening department, which is another long building, 625 × 47 ft., parallel to the mill.

From the hot beds the rails are pushed onto a line of driven rollers, which extends the whole length of the finishing department, and by which they are carried along. The rollers are driven by two small, double reversing engines, so that the rails can be sent forward or backward as desired. When a rail reaches the proper point two arms are raised by the action of a steam cylinder and piston, controlled by a lever. These arms lift the rail from the rollers, and as the arms are inclined at a steep angle, the rail slides down onto the cold bed, close to the straightening press. There are two cold beds for each of the 8 straightening presses, and there are 6 drill presses. These are operated by an engine, 16 × 21 in. The finished rails are pushed out of the side of the building to the loading beds, which cover a space of 650 × 54 ft. The loading beds are above the level of the common platform car, so that the loading to cars for shipment is very rapid.

At the northeast end of the finishing department is a cold saw for cutting rails to special length. In addition to the finishing department above, one straightening press, two drill presses and two cold saws, in the old rail mill annex, are in use.

The roll shop is in a wing 60 × 60 ft. on the north side of the roll trains. A platform, parallel to the line of roll trains, serves to store extra rolls. A rail track runs alongside this platform and between the roll trains and the platform, so that the rolls are easily conveyed on cars.

The steam for the steel department is furnished by the following boilers:

12 boilers, 28 ft. long, 54-in. diameter, 2 flues.
2 " " " " 2 "
4 " " 48 in. " 2 "
8 " " 54-in. " 4 "
24 " " 54-in. " 3 "
2 Heine boilers, 16 ft. long, 2 flues, 30-in. diameter, with 113 tubes, 3½-in. diameter.

In addition to the above there are under construction 20 boilers, 28 ft. × 54 ins., each with two flues, 18-in. diameter.

The electric light plant consists of three Brush 65-light dynamos, running about 175 arc lamps. Power is provided by three 11 × 22-in. Buckeye engines.

The Projected Simplon Tunnel Temperatures.

Prof. VON RZIHA, of Vienna, has published a memoir, on the project of the Simplon railway, abstracted in *Glasers Annalen*, which contains principally, a critical consideration of the plans hitherto advanced for the construction of the great tunnel to be built for this road.

Since the earlier, 1878, project (see plan Fig. 1) for the railway, with a tunnel 11.48 miles long, has been given up because of the uncertain nature of the mountain, at present two projects stand opposed, namely, that of 1882 with low lying tunnel, 12.42 miles long, and the project of

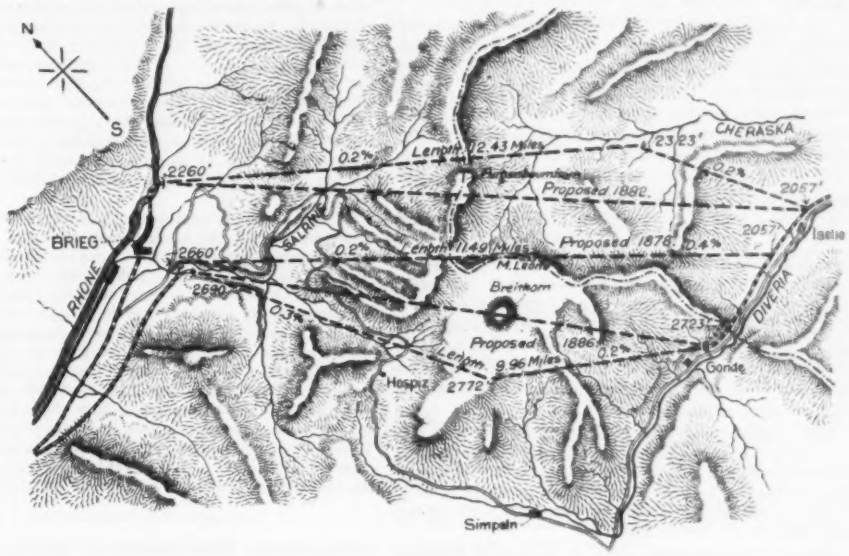


FIG. 1.—PROPOSED ROUTES FOR A SIMPLON RAILWAY.

1886 with a tunnel 9.93 miles long lying 450 ft. higher. The latter has the advantage of an important saving in cost estimated at about $5,000,000. Finally, to further reduce the total cost of the undertaking, some $16,800,000, the question has been mooted whether it would not be allowable to construct the upper 9.93-mile tunnel for a single track, whereby a saving of from $1,400,000 to $1,600,000 might be possible.

In both plans the line has been laid out, not straight but broken, to avoid piercing especially high peaks, viz., the Furgenbaum-horn, 9,840 ft. by the lower tunnel, and the Breithorn, 10,020 ft. by the higher tunnel. Herr VON RZIHA declares himself unreservedly in the said memoir against these deviations, since the length of the lower tunnel would thereby be increased 1,180 ft. and that of the upper 1,800 ft., corresponding to an increase in the cost of from $250,000 to $375,000, while the amount of heat to be expected in the interior of a mountain is uncertain. It must, he adds, appear doubtful whether or not a single high mountain peak would occasion a notable increase of heat.

He gives hereupon a graphical method based upon experiments made in the older Alpine tunnels by means of which we can infer approximately the highest temperature to be expected in the present case.

For this purpose (see accompanying diagram, Fig. 2) the interior temperatures found during the construction of the Mt. Cenis, Gothard and Arlberg tunnels are taken as ordinates and the corresponding depths below the surface as abscissas, and a curve is drawn giving the mean of these observations. The curve is approximately a parabola.

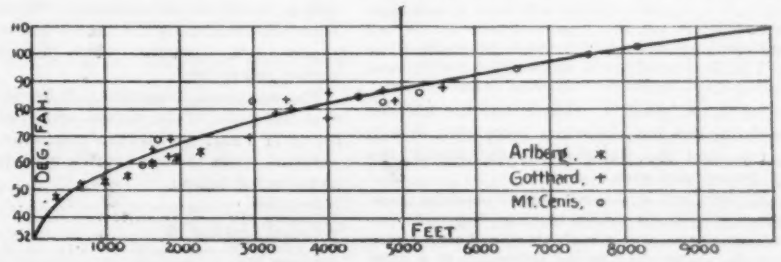


FIG. 2.—DIAGRAM OF TUNNEL TEMPERATURES.

In the present case the greatest depth below the surface in the lower tunnel is 6,560 ft., in the higher tunnel 7,544 ft., and the diagram indicates probable temperatures of about 35° C. and 37° C. (95° and 98.6° Fahr.) as the highest to be expected.

Herr VON RZIHA decides unconditionally in favor of the lower tunnel, since it will only thus be possible to successfully compete with the St. Gothard—finally he pronounces against the construction of the upper tunnel for a single track, not from any technical difficulties in construction or ventilation, but from the fact that in a tunnel of such unusual length and single track, in case of important work or repairs being needed through accident or otherwise, it would be impossible to carry it out without a complete discontinuance of the traffic—which he considers would be of immeasurable injury to the road, and would bring it forever into discredit.

Conflicting Legal Opinions as to the Contamination of a Water Supply.

In the Pittsburg *Dispatch* of Oct. 26, is a résumé, evidently written by a lawyer, of an interesting trial before the Pennsylvania Supreme Court relating to the contamination of a water supply by mining operations on neighboring property.

The case cited is that of ELIZA MCBRIAR SANDERSON vs. the Pennsylvania Coal Co. She built twenty years before, a fine residence near Scranton, Pa., and through her property ran a pure stream called Meadow Brook. By means of hydraulic rams she

supplied her house with water for all domestic purposes, and constructed fine fish-ponds, fountains, etc. Some years later the coal company sunk a shaft on its property near by and drained the mine water into Meadow Brook, making the water totally unfit for use, and corroding steam boilers, rams, etc., with the mineral acid in the mine water. The suit for damages followed, and, after being four times before the Supreme Court, was finally settled on Feb. 2, 1886, by the denial of any legal claim for damages and the reversal of a verdict by the lower courts.

The main points of this decision were as follows: Before the Supreme Court the company's counsel held that the true theory of negligence, as developed in the law of torts, both in England and in this country, is: Damages resulting to another from the natural and lawful use of his land by the owner thereof are, in the absence of malice, *damnum absque injuria;* and the corollary of this rule is: When the maxim *sic utere tuo ut alienum non lædus* is applied to landed property, the plaintiff must show not only that he has sustained damage, but that the defendant has caused it by going beyond what is necessary, in order to enable him to have the natural use of his own land. If a defendant confines himself to the necessary means of lawful enjoyment of his land, the damage arises not from his act, but *ex necessitate*, and the plaintiff's loss is as much the result of *vis major*, the act of God, as though caused by lightning or flood.

The company's attorneys claimed that:

"If, in our case, we cannot use our land for the natural purpose of mining coal, because our neighbor cannot keep tame fish in his pond, the same rule should apply to him. He should not be allowed to maintain a fish pond so near our mine that we cannot use it."

They cited numerous cases to show that English law on the case had not been regarded as law in the United States. It was also held that the right of mine owners to drain into rivers has always been recognized, or at least has always been acquiesced in in this State.

In delivering his opinion, Justice CLARK observed, among other things:

Defendants had done nothing to change the character of the water except what resulted from the natural use and enjoyment of their own property. A man is entitled to the ordinary and natural use of his property, may cut down forest trees, etc., although in so doing he may dry up the sources of his neighbor's springs, or remove natural barriers against storms. If, in the excavation of his land, he uncovers a spring of water, salt or fresh, acidulated or sweet, he is certainly not obliged to cover it again, or to conduct it out of its course, lest the stream in its natural flow may reach his neighbor's land. Defendants, being the owners of the land, had a right to mine the coal while lawfully in use and improvement of their property. An unavoidable loss occurred to their neighbors without negligence or malice on their part, it is *damnum absque injuria*, for the rightful use of one's own land may cause damage to another without any legal wrong. . . . We do not say that a case may not arise in which a stream from such pollution may not become a nuisance and that the public interests, as interested in the general health and well-being of the community, may not require the abatement of the nuisance.

Justice CLARK goes on to state that the citizens of Scranton did not make any complaint, though they, too, used the water of Meadow Brook, the stream fouled, and adds:

The plaintiff's grievance is for a mere personal inconvenience, and we are of opinion that a mere private personal inconvenience, arising in this way and under such circumstances, must yield to the necessities of a quiet public industry, which, although in the hands of a private corporation, subserves a great public interest. To encourage the development of the great natural resources of a country, trifling inconveniences to particular persons must give way to the necessities of a great community. . . .

As a general rule, those who engage in an an undertaking, attended with the risks to their neighbors, are answerable for the conduct of that undertaking, with diligence proportioned to the apparent risk, and this would seem be the better rule. There is a well-known line of cases in Philadelphia and elsewhere which decide that a stream of water may not be fouled by the introduction into it of any foreign substance, to the damage and injury of the lower riparian owners, but in this case defendants introduced nothing into the water to corrupt it; the water flowed into Meadow brook just as it was found in the mine; its impurities were from natural and not from artificial causes.

It may be said that if the mines had not been opened the water which flowed into the stream would have been pure, but as Chief Justice Lewis said in Wheatly vs. Baugh, 1 Casey, 532, "the law has never gone so far as to recognize in one man the right to convert another's farm to his own use for the purposes of a filter." No case in Pennsylvania has been brought to our notice in which the precise question appears to have been decided.

Justices PAXON, now Chief Justice, and Justice GORDON dissented from this decision. The latter said, in substance:

If the pollution of the brook resulted from the necessity of coal mining and the right of the plaintiffs must yield to it as an industry important to the commonwealth as argued, the argument was fallacious, as the private interests of the defendants and not the public welfare were involved. No industry, however important, can claim the right to take and use the property of the citizen without compensation. . . . It is urged that mining cannot be carried on without this flow of acidulous water, hence, of necessity, the neighboring streams must be polluted. This is true, and it is also true that coal mining would come to nothing without roads, but it does not follow that for roads the land of an adjacent owner may be taken or his right of way encumbered without compensation. . . .

If, indeed, the custom set up were to prevail, then, at least so far as coal mining companies are concerned, there would be an abrogation of the eighth section, article 14, of the Constitution, which provides that "municipal and other corporations invested with the power of taking private property for public use shall make just compensation for property taken, injured, or destroyed by the construction and enlargement of their works, highways, or improvements." Not only would we thus have a custom superior to the supreme law of the land, but one reaching even beyond the possible sovereignty of the State, in that it would empower private persons for private purposes to injure or destroy private property, and that without compensation. A custom such as this is radically bad, and cannot be sustained."

Temperature Observations in the St. Gothard Tunnel.

In connection with the investigation into underground temperatures, made by Professor VON RZIHA, of Vienna, and published in this issue, the report of M. BECHTLE on the change in conditions in the St. Gothard tunnel is particularly interesting. The report of Mr. BECHTLE, to 1888, is contained in a late number of the *Schweizerische Bauzeitung* and is in substance as follows:

During the construction of the St. Gothard tunnel it was a question whether the natural draft would be sufficient to ventilate the tunnel up to the time of the meeting of the headings, and as a basis of possible artificial ventilation a series of careful observations of temperature were made. To this end thermometers were placed in the 15 refuge chambers in the tunnel and readings of temperature were taken every 8 hours, also the power and direction of the air currents and the density of the mixture of air and smoke. At the same time the exterior atmospheric conditions were observed at stations at Göschenen, at the north end of the tunnel, and at Airolo, at the south end. These observations were continued after the tunnel was opened and the report of M. BECHTLE refers particularly to the period 1883 to 1888.

The maximum temperature is found at refuge No. 8, at the center of the tunnel, and is about constant (73° to 74° Fahr.*), while the minimum annual temperature tends to decrease in a continuous manner as indicated below:

March, 1883	61.52°
February, 1884	60.80°
February, 1885 and '86	59.00°
December, 1887	58.64°
January, 1888	58.10°

During the construction of the tunnel, the following annual averages were taken for the temperature in the headings:

Side of Mountain.	1876	1877	1878	1879	1880
North. During driving	66.92°	69.98°	75.20°	79.52°	86.54°
After a blast	69.44	74.12	78.80	84.74	88.16
South. During driving	73.58	77.00	78.44	82.76	84.74
After a blast	79.88	84.30	84.74	87.26	87.80

Before the meeting of the headings, which took place on Feb. 29, 1880, the mean temperature in the heading coming from Göschenen ranged from 79.88° to 85.23°, and from the Airolo, or south side, from 84.56° to 88.88°. The increase in the volume of compressed air delivered during that month only lowered the temperature 3.06°, as compared with that of the rock itself.

The temperature of the rock was as follows: At 25,043 ft. in from the north end, with an overhead thickness of 5,589 ft., the thermometer read 87.08°. At 23,094 ft. from the south end, with overlying rock 4,854 ft. thick, it was 84.92°. The mean initial temperature of the rock through the entire length of the tunnel was 74.12°. This temperature was lowered in Feb., 1880, to 72.63°; in Feb., 1881, to 66.74°, and in Feb., 1882, to 57.56°. These figures show clearly the steady reduction that took place in the mean temperature of the rock throughout the tunnel.

Observations made since the opening of the tunnel have furnished the following results relating to rock temperature:

Date.	At 2,394 ft. inside north heading, in a hole 3.28 ft. deep.		At 22,124 ft. inside south heading, in a hole 3.61 ft. deep.	
	Air.	Rock.	Air.	Rock.
July, 1882..	68.18°	75.02°	69.98°	76.10°
July-Aug. '8	67.82	71.96	69.08	73.40
Decrease		3.06°		2.70°

In observing the movement of air currents these were registered for direction, and as "great, moderate, feeble or calm." These currents produced a natural draught in the tunnel as a result of the difference in pressures at the two ends due to their difference in level. This air column, which had a height of 118.08 ft., acted sometimes in the direction of the prevailing wind, and at other times against the outside current, as the air in the tunnel was lighter or heavier than the outside air. The combined effect of the difference of temperatures and of the humidity at the two ends of the tunnel have given the following results in the distribution of air currents; the draft acting continuously towards the north or south for some days, or changing in direction at short intervals. In the latter case this is the natural result of periods of calm; but none of these lasted longer than half of a day:

Year.	No. of days north current ruling.		No. of days south current ruling.		No. of days north and south currents alternating.	
	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.
1883..	70	75	45	29	66	80
1884..	60	82	56	42	67	59
1885..	51	80	64	53	67	68
1886..	55	70	60	54	67	59
1887..	65	79	45	40	72	64

NOTE.—Winter includes the months from October to March. The summer from April to September inclusively.

These figures indicate that the north current is more frequent during the summer months, and that there is little regularity in the direction of either current. The changeable days are practically the same in number in the two seasons. The wind ruling at the stations at the extremities of the tunnel seems to have no influence on either the duration or the power of air currents in the tunnel; and a train passing through simply acts as a piston, and exerts only a local and almost insignificant effect.

The observations relating to smoke were made in whole days, and classified as "entirely, half, slightly smoky, and without smoke." The number of smoky days was greater at the south extremity than at the north, and more in summer than in the winter. The middle of the tunnel was rarely ever completely smokeless, generally coming under the head of "slightly smoky;" but, on the contrary, the number of days "entirely smoky" was much less than at the extremities of the tunnel. The most unfavorable conditions were when the wind was light and changeable in direction.

The present work in the tunnel, on maintenance of way, is carried on as much as possible when the air current is established in one direction or the other, or during the night when the number of trains is reduced to two. Passengers on trains find no inconvenience in passing through the tunnel, provided they close the windows. The observations continued through the last six years have fully demonstrated the fact that the ventilation of the tunnel is secured naturally and constantly by air currents passing in one direction or the other. The observations on smoke have been discontinued and Mr. BECHTLE thinks it is useless to pursue further those relating to temperatures and air currents.

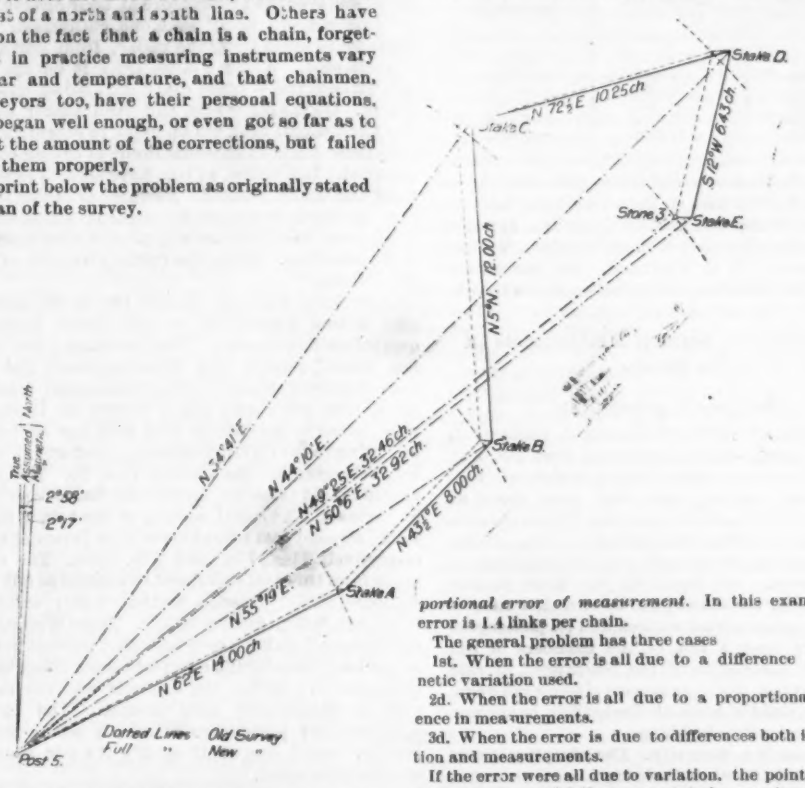
*All temperatures are given in Fahrenheit.—ED.

That Problem in Surveying.

In ENGINEERING NEWS of Aug. 16, 1890, reference was made in the editorial columns to a practical problem in surveying proposed for solution by Mr. F. HODGMAN, of Climax, Mich. The statement of the problem was published for three successive weeks in the advertising pages. About forty answers have been received, but of these only nine are correct.

Some have erred by not taking the wording of the problem as exact, supposing that when the new survey is said to come out 62 links east of the original stone it does not mean due east, but somewhere to the east of a north and south line. Others have insisted on the fact that a chain is a chain, forgetting that in practice measuring instruments vary from wear and temperature, and that chainmen, and surveyors too, have their personal equations. Several began well enough, or even got so far as to work out the amount of the corrections, but failed to apply them properly.

We reprint below the problem as originally stated and a plan of the survey.



The field notes of a line of highway read as follows: Commencing at Meander Post No. 5, and running thence N. 61°, E. 14.00 chains; 2d N. 43½°, E. 8.00 chains; 3d N. 5° W. 12.00 chains; 4th N. 72½°, E. 10.25 chains; 5th S. 12°, W 6.43 chains, to a stone set for Meander Post No. 3. I commence at Meander Post No. 5, and with a variation 2° 17' E° run a random line according to the field notes, setting temporary stakes at each angle in the line, and come out 62 links east of Meander Corner Stone No. 3. 1. What is the correction for the variation of the needle? 2. What is the correction for the stake at each angle, and how shall I find it?

What seems to be the best practical method of solving the problem has been submitted by Mr. F. A. STEIGER.

The solution is embodied in the following table:

a Station.	*b* Course.	*c* Distance	*d* Lat.	*e* Dep.	*f* Total Lat.	*g* Total Dep.	*h* $\frac{g}{f}$	*i* Courses.	*j* i + Constant angle.	*k* $\frac{n}{m} \times \frac{g}{\sin i}$	*l* $\frac{g}{\sin i}$
Stake *A*...	N. 62° E.	14.00	+ 6.57	+12.36	+12.36	+ 12.36	1.881	N. 62° E.	N. 78°-6' W.	.26	.....
" *B*...	N. 43½° E.	8.00	+ 5.80	+ 5.51	+17.87	+ 17.87	1.445	N. 55°-19' E.	N. 84°-47' W.	.41	.....
" *C*....	N. 5° W.	12.00	+11.95	- 1.05	+16.82	+ 16.82	.692	N. 34°-41' E.	S. 74°-35' W.	.56	.....
" *D*...	N. 72½° E.	10.25	+ 3.08	+ 9.78	+25.60	+ 26.60	.971	N. 44°-10' E.	S. 84°-4' W.	.72	.....
" *E*.	S. 12° W.	6.43	- 6.29	- 1.34	+25..6	+ 25.26	1.193	N. 50°-6' E.	West.	.62	32.92
Stone No. 3	West.	.62	0.00	- .62	+25.64	+ 24.64	1.167	N. 49°-25' E.	.....	...	32.16

Columns *a*, *b*, *c*, *d*, *e*, *f* and *g* need no explanation. In column *h* the total departure of each course is divided by its total latitude, giving the tangent of the angle which a line connecting the extremity of that course and the starting point makes with a north and south line. In column *i* this angle is given, with its proper naming, so that we have the courses of the lines connecting with the starting point. In column *j* we have this course affected by a constant angle. This constant angle is found between the lines connecting the starting point, and Stone 3 of the original survey, with Stake *E*. The courses given in column *j* are *the courses to be used in shifting the stakes from their positions in the new survey to their positions in the original survey.*

Column *k* gives *the distance that each stake is to be moved.* These distances are proportional to the distances of the stakes from the starting point. In the expression, $\frac{n}{m}\left(\frac{g}{\sin i}\right)$, m is the distance of Stake *E* from the starting point (32.92), and n is the error of closing (62 links).

The closing course and distance (west 62 links) are included in the table. The angular difference between the last two courses in column *i*, 41', is *the required error of variation.*

In column *l* the distance between post 5 and stake *E*, and that between post 5 and stone 3 $\left(\frac{g}{\sin i}\right)$ of the last two courses, are given. The difference (46 links) between these distances, when taken in connection with the distance (32.92 chains) from post 5 to stake *E*, gives *the proportional error of measurement.* In this example this error is 1.4 links per chain.

The general problem has three cases

1st. When the error is all due to a difference in magnetic variation used.

2d. When the error is all due to a proportional difference in measurements.

3d. When the error is due to differences both in variation and measurements.

If the error were all due to variation, the points of the new survey would fall on arcs of circles passing through the corresponding points of the old survey, and having the starting point as a common center. The amount of arc included between the old and the new points would measure the error of variation. The chords of these arcs would be proportional to the distances of the points from the starting point, and their lengths could be found when we knew the closing distance, which, in this case, would be a chord of one of the arcs. These chords make constant angles with the lines to the starting point, and their courses can be determined after we have determined the courses of these lines from the total latitudes and departures of the points which they connect with the starting point (as in this case).

If the error were all due to a proportional difference of measurements the points of the new survey would fall on lines connecting the corresponding points of the old survey with the starting point. The distances between the old and new points would be in proportion to the distances of the new points from the starting point, and could be found when we knew the closing distance, which in this case would fall on the line connecting the last station with the starting point.

If the error were due to both a proportional difference of the measurements and a difference of the variation used, the points of new survey would fall neither on the arcs through the corresponding points of the old survey nor on the lines connecting these points with the starting point.

We have found that the corrections for variation and for measurements are both proportional to the distances of the new points from the starting point—that the directions of the lines correcting the measurements are along the lines connecting the new points with the starting point, and that the directions of the lines correcting the variation are such that they make constant angles with the lines connecting the new points with the starting point.

From these considerations it easily be seen that the two corrections are proportional to each other—that they make a constant angle with each other—and, therefore, that a line connecting each new point with its corresponding old point will be in proportion to, and make a constant angle with, the lines connecting the new points with the starting point. Although we have three cases, the rule for making the corrections will be the same. Rule:

"Lay off from the new point, lines whose directions are such that they make the same angles with the lines to the starting point, as the closing line does with the line connecting the last station with the starting point, and whose lengths bear the same proportion to the lines to the starting point as the closing distance does to the line from the last station to the starting point."

We get the error of variation and the proportional error of measurements from the difference between the courses and the difference in lengths of the lines connecting the known point of the old survey and the corresponding point of the new survey with the starting point, which is common to both old and new surveys.

In an actual case, the amount of work would be greatly reduced by plotting the survey and scaling the angles and distances.

The following ingenious solution comes from Mr S. W. FRESCOLN:

Designate successive corners by No. 5, *A*, *B*, *C*, *D*, No. 3

Line.	Bearing.	Distance chains.	
No. 5—*A*	N 62° E	14.00	
A—*B*	N 43° 30' E	8.00	Assumed variation
B—*C*	N 5° 00' W	12.00	= 2° 17' E
C—*D*	N 72° 30' E	10.25	
D—No. 3	S 12° 00' W	6.43	Error of closure. Northings = 0 Eastings = 62 links.

The total error is due to a combination of *error in variation* and *error in chain.*

Let y = error in chain per chain.

Let $10x$ = correction to variation in minutes.

∴ Bearings of random line *differ* from bearings of true line by $10x$ minutes.

A table of nat. sines and cosines gives difference in cos and sin (or lat. and dep.) for each bearing due to a change of 10'; these values multiplied by x and the length of the course will hence produce the errors in lat. and dep. for that course due to the error in variation. In this manner from Table 1.

TABLE 1.

Errors in lat. and dep. due to error in variation.

Course	No. 5—*A*	*A*—*B*	*B*—*C*	*C*—*D*	*D*—No. 3.
Lat.	−.035*x*	−.016*x*	+.002*x*	−.029*x*	+.004*x*
Dep.	+.020*x*	+.017*x*	+.035*x*	+.009*x*	−.019*x*

Summing—Total error in lat. due to variation... = −.075*x*
" " " dep. " " " ...= +.062*x*

Also length of each course multiplied by y and then respectively by cos and sin of bearing will produce the errors in lat. and dep. of each course due to error in chain. Thus form table 2:

TABLE 2

Errors in lat. and dep. due to error in chain.

Course	No. 5—*A*	*A*—*B*	*B*—*C*	*C*—*D*	*D*—No. 3.
Lat.	− 6.58*y*	− 5.80*y*	− 11.95*y*	− 3.08*y*	+ 6.29*y*
Dep.	− 12.36*y*	− 5.50*y*	+ 1.04*y*	− 9.78*y*	+ 1.34*y*

Summing—
Total error in lat. due to error in chain ..... = − 21.12*y*
" " dep. " " " ..... = − 25.26*y*

Resultant errors = sum of these two, and hence form

(Lat.) the equations: −.075*x* − 21.12*y* = 0 (1)

(Dep.) + .062*x* − 25.26*y* = .62 (2)

Solve and find $y = -.014$ (∴ chain is too long)

$x = 4.00$.

∴ $10x$ = 41 minutes; corrected variation = 2° 58' E. Substitute values of x and y in tables 1 and 2, which, as results are only wanted to nearest link, can in this and in most cases be done mentally, and then by simple addition find corrections for each station, as is clearly shown by following tables:

TABLE 3.

Corrections in links per course due to variation.

Course	5—*A*	*A*—*B*	*B*—*C*	*C*—*D*	*D*—3
Lat.	+ 15	+ 7	− 1	+ 11	− 3
Dep.	− 8	− 7	− 15	− 4	+ 8

TABLE 4.

Corrections in links per course due to chain.

Course	5—*A*	*A*—*B*	*B*—*C*	*C*—*D*	*D*—3
Lat.	− 6	− 8	− 17	− 4	+ 9
Dep.	− 17	− 8	+ 1	− 14	+ 2

TABLE 5.

Corrections in links per course due to both.

Course	5—*A*	*A*—*B*	*B*—*C*	*C*—*D*	*D*—3
Lat.	+ 1	− 1	− 18	+ 7	+ 6
Dep.	− 25	− 15	− 14	− 18	+ 10

TABLE 6

Corrections in links per station; obtained by adding to each column of Table 5 the sum of all that precedes.

Station	*A*	*B*	*C*	*D*	No. 3
Lat.	+ 6	+ 5	− 12	− 6	0
Dep.	− 25	− 40	− 54	− 72	− 62

If the error in variation were simply desired without wishing the corrections per station, it can be obtained very simply, viz.: by dividing the total error of closure by

the total distance, which will be the *sin* of the angular error, near enough for all practical purposes. In fact, it gives 42 minutes instead of 41 minutes, which of course is near enough.

Below we give one other method of working out the problem. This was sent by Mr. EDWARD A. STOCKWELL.

Let α = correction to the length of chain used on random line.

Let θ = correction to the assumed variation of the needle.

Let x_0 and y_0 = departure and latitude of the true terminal point referred to the starting point as origin.

Let x_1 and y_1 = departure and latitude of the terminal point of the random line referred to the same origin.

Let the bearings be denoted by a, a', a'', a''', etc.

Let the number of chains in the corresponding courses be denoted by n, n', n'', n''', etc.

Then we shall have:

$$(1+\alpha)\, n \sin(a+\theta) + (1+\alpha)\, n' \sin(a'+\theta) + (1+\alpha)\, n'' \sin(a''+\theta) + \text{etc.} = x_0 \quad (1)$$

$$\text{and } (1+\alpha)\, n \cos(a+\theta) + (1+\alpha)\, n' \cos(a'+\theta) + (1+\alpha)\, n'' \cos(a''+\theta) + \text{etc.} = y_0 \quad (2)$$

but $\sin(a+\theta) = \sin a \cos\theta + \cos a \sin\theta$,

and $\cos(a+\theta) = \cos a \cos\theta - \sin a \sin\theta$.

Substituting these values in (1) and (2), and in the results substituting for $\cos\theta$ the value $1 - 2\sin^2 \frac{1}{2}\theta$, we have

$$(1+\alpha)\,[n(\sin a - 2\sin a \sin^2 \tfrac{1}{2}\theta + \cos a \sin\theta) + n'(\sin a' - 2\sin a' \sin^2 \tfrac{1}{2}\theta + \cos a' \sin\theta) + \text{etc.} = x_0 \quad (3)$$

$$\text{and } (1+\alpha)\,[n(\cos a - 2\cos a \sin^2 \tfrac{1}{2}\theta - \sin a \sin\theta) + n'(\cos a' - 2\cos a' \sin^2 \tfrac{1}{2}\theta - \sin a' \sin\theta) + \text{etc.} = y_0 \quad (4)$$

$$\text{but } n \sin a + n' \sin a' + n'' \sin a'' + \text{etc.} = x_1 \quad (5)$$

$$\text{and } n \cos a + n' \cos a' + n'' \cos a'' + \text{etc.} = y_1 \quad (6)$$

Substituting these values in (3) and (4), we have

$$x_1 + \alpha x_1 + \sin\theta\, y_1 + \alpha \sin\theta\, y_1 - 2\alpha \sin^2 \tfrac{1}{2}\theta\, x_1 = x_0 \quad (7)$$

$$\text{and } y_1 + \alpha y_1 - \sin\theta\, x_1 - \alpha \sin\theta\, x_1 - 2\alpha \sin^2 \tfrac{1}{2}\theta\, y_1 = y_0 \quad (8)$$

Since α and θ are very small, we may put $\sin\theta = \theta$, and $\sin^2 \frac{1}{2}\theta = \frac{1}{4}\theta^2$, and $\alpha \sin^2 \frac{1}{2}\theta = \alpha \frac{1}{4}\theta^2 = 0$ by neglecting terms of the third order; substituting these values in (7) and (8) and reducing, we have

$$\alpha + \frac{y_1}{x_1}\theta = \frac{x_0 - x_1}{x_1} - \frac{y_1}{x_1}\alpha\theta + \tfrac{1}{2}\theta^2 \quad (9)$$

$$\text{and } \alpha - \frac{x_1}{y_1}\theta = \frac{y_0 - y_1}{y_1} + \frac{x_1}{y_1}\alpha\theta + \tfrac{1}{2}\theta^2 \quad (10)$$

$$\text{from which } \theta = \frac{x_0 y_1 - x_1 y_0}{(x_1^2 + y_1^2)(1+\alpha)} \quad (11)$$

Multiplying (7) and (8) by x_1 and y_1 respectively, adding and reducing, we get

$$\alpha = \frac{x_1(x_0 - x_1) + y_1(y_0 - y_1)}{x_1^2 + y_1^2} + \tfrac{1}{2}\theta^2 \quad (12)$$

$$\text{and } 1 + \alpha = \frac{x_0 x_1 + y_0 y_1}{x_1^2 + y_1^2} + \tfrac{1}{2}\theta^2 \quad (13)$$

Solution to Problem in Engineering News, Aug. 16, 1890.

11 cos	62°	=	+ 6.57.6
8 cos	43½°	=	+ 5.80 9
12 cos	5°	=	+ 11.9543
10 25 cos	72½°	=	+ 3.0823
6.43 cos	— 168°	=	— 6 2895
		y_1 =	+ 21.1226
		y_0 =	+ 21.1223

11 sin	62°	=	+ 12.3613
8 sin	43½°	=	+ 5.5068
12 sin —	5°	=	— 1.04.9
10.25 sin	72½°	=	+ 9 7757
6.43 sin	— 16?°	=	— 1.3369
		x_1 =	+ 25 2610
		x_0 =	+ 21.6410

$y_0 = y_1$

$x_0 = x_1 - 0.62 \propto + 21.6410$

Substituting these values in equation (11), disregarding α we have

$$\theta = \frac{24.6410 \times 21.1226 - 25.2610 \times 21\ 1226}{25.2610^2 + 21.1226^2} = -0.012078$$

Substituting these same values in equation (12), we have

$$\alpha = \frac{25.2610 \times -0.62}{25.2610^2 + 21.1226^2} + 0.000075 = -0.01138$$

$$\text{and } 1 + \alpha = 1 - 0.01438 = + 0.98562$$

$$\text{hence } \theta = \frac{-0.012078}{0.98532} = -0.012255 = -0°\ 42'\ 7''.8$$

and the magnetic variation $= -2°\ 27' - 0°\ 42'\ 7''.8 = -2°\ 59'\ 7''.8$, *i. e.*, 2° 59' 7.''8 East.

Now, multiply the given length of each course by $(1+\alpha) = 0.98562$ to get the length of true courses and add $-0°\ 42'\ 7''.8$ to the preceding bearings, and we have

13.7984 cos	61° 17' 52''	=	+ 6.6269
7.8848 cos	42° 47' 52''	=	+ 5.7857
11.8272 cos	5° 42' 08''	=	+ 11 7689
10.1024 cos	71° 47' 52''	=	+ 3.1558
6.3374 cos	— 168° 42' 08''	=	— 6.2147
		y_0 =	+ 21 1226

13.7984 sin	61° 17' 52''	=	+ 12.1033
7.8848 sin	42° 47' 52''	=	+ 5.3782
11.8272 sin	— 5° 42' 08''	=	— 1.1751
10.1024 sin	71° 47' 52''	=	+ 9.5972
6.3374 sin	— 168° 42' 08''	=	— 1.2416
		x =	+ 24.641

Refer the latitude and departure of each station on both lines to the starting point, and we will get the following table of corrections:

	Latitudes, random line.	Latitudes, true line.	Correction.
			North.
Sta. 1	+ 6.5726	+ 6.6269	+ 0 0543
" 2	+ 12.3755	+ 12 4126	+ 0.0371
			South.
" 3	+ 24.3298	+ 24 1815	— 0 1483
" 4	+ 27.4121	+ 27.3373	— 0.0748
" 5	+ 21.1.26	+ 21.1226	0.0000

Departure, random line.	Departure, true line.	Correction.
		West.
+ 12.3613	+ 12.1033	— 0.2580
+ 17.8651	+ 17.4605	— 0.4976
+ 16.8222	+ 16. 854	— 0.5 68
+ 26 5979	+ 25.8826	— 0.7153
+ 25.2610	+ 24 6110	— 0.6200

Correct solutions, some of them quite as satisfactory as any but the first of the above, have been received from Messrs. J. FOSTER CROWELL, HORACE ANDREWS, D. E. HUGHES, WM. M. WHITTEN, VICTOR C. HILLS, and HITT & WILLIAMS. But we cannot find space for more than the typical ones here shown.

The British and German Metallurgists in the South.

(*Continued from page* 321.)

THE BIRMINGHAM DISTRICT—NATURAL RESOURCES.

The party going South numbered just 255, and was carried in three special trains, which left Chicago Tuesday evening, and, with brief stops at Louisville and at Nashville, reached Birmingham in the small hours of Thursday morning. The all-day ride of Wednesday was a rather novel experience to the foreigners. At Nashville the first section was delayed for an hour by the failure of a tube in the engine of the second section, and its passengers had time to meet a few of the members of the Engineering Association of the Southwest, to ride on some of the city's numerous electric railways, and to get a sight of some of Nashville's handsome residences and public buildings.

Birmingham is a busy city. The sleeping excursionists thought so when their train came to a stop in the yard at an early hour and a switching engine pulled up beside them, blew off steam at frequent and regular intervals, and finally exhausted the remaining contents of the boiler through the whistle, according to the verdict of the sleepy passengers.

This salute was certainly conducive to early rising; but notwithstanding the hour at which the party made its several toilets and breakfasted, the Birmingham Reception Committee was on hand to welcome them, by the time these preliminaries were concluded. Evidently the old dilatory habits of the South have received a great impetus since the new era of industry began, in the iron districts at least.

For the day's excursion two special trains had been made up by the Louisville & Nashville and Alabama Great Southern Railway Companies, and these carried the party north and east about 6 miles to Gate City, which is not a city at all, but a limestone quarry, situated on the mountain side about 300 ft. above the plain on which Birmingham is built. A roughly built spur track winds up the mountain side to the quarry, with steep grades, sharp curves and high trestles. A special train carried the party up the mountain with no more serious casualty than a derailment of one car truck on the edge of a steep precipice, just as the train came to a halt. It must be confessed that the ballast under the ends of the ties on the down-hill side was conspicuous by its absence. The man with the crowbar, who is said to be required to hold up the trestles on some Southern roads when a train passes, was also not to be seen, although the need for him was manifest; and the foreigners breathed more freely after the return journey had been safely made.

Certainly Gate City seems a good place to quarry limestone. The rock is easily broken; it is carried on gravity tracks from the quarry to the crushers; it falls from the quarry cars into the crushers, and thence into hopper cars on the standard gauge track, and the waste is also dumped by gravity into a ravine, which it will require very many years to fill. Limestone from this quarry can be delivered on the stock piles at any of the furnaces about Birmingham for 60 cts. per ton.

From Gate City the trains moved south along the slope of Red Mountain, giving the party a magnificent view of Birmingham in the valley over 300 ft. below. The next stop was at the Eureka ore mines of the De Bardeleben Coal & Iron Co., where the Red Mountain vein lies so near the surface that it is worked in an open cut. The vein here is 24 ft. thick. The ore for the first 17 ft. from the surface carries about 40.35 % iron, 14.88 % silica, and 0.20 % lime. Lower down the lime rises as high as 24.31 %.

At this point the Birmingham people grew enthusiastic over the great future of their district.

"This red ore vein," said one enthusiast, "extends for 60 miles along the valley, from northeast to southwest. Within 8 miles from it on the one side extends the Warrior coal field, 7,800 sq. miles in extent. On the other side, and even nearer by, is the Cahaba coal field, 480 sq. miles in extent. From both these fields an excellent grade of coking coal is obtained. Limestone, as you have seen, is close at hand and easily worked. Nowhere are these three raw materials necessary for pig-iron manufacture brought so close together and in such abundance as at Birmingham. Hence the future greatness of the city follows."

"How long will this deposit last, at the present rate of iron production in the United States?" queried an Englishman. "Just two and a half million years," replied the Birminghamer; and the statement was accepted with some mental reservations. The other two points visited on Thursday were mines in the Cahaba coal field, one at Adger, belonging to the De Bardeleben Co., and one at Blocton, belonging to the Cahaba Coal Co. The first named is said to be the largest workable coal vein in Alabama. A typical section of the vein is 8½ ft thick, all solid coal except three thin layers of slate respectively 2 ins., 1 in., and ½ in. thick. The coke made from this coal is claimed to analyze as follows: Moisture, 0.25%; volatile matter, 0.40%; sulphur, 0.82%; ash, 6.20%; carbon, 92.32%. There is no doubt that this coal makes a very fair coke: perhaps nearly as good as Connellsville coke; but some doubt is expressed as to whether the analysis was not made upon a particularly good sample. The extraordinarily low percentage of ash, it seems pretty certain, would rise to 12 or 13% if a fair average sample were taken.

The mine is worked through a slope and the coal comes out very cheaply. The mine at Blocton is also worked by a slope, which has been extended to a point 1,800 ft. from the entrance. This mine also produces fair coking coal, and it is nearer to the sea coast than any other mine in Alabama. As it is located only about 35 miles from the head of navigation on the Coosa river, it is most convenient for shipments by water to Gulf and Eastern ports, and some export trade has already begun in this direction. This mine also furnishes coke to the furnaces working on brown ore in the Anniston district.

In the evening, after their return to Birmingham, the visitors were given a reception at the Alabama Club. A graceful speech of welcome was made by Capt. JOS. Y. JOHNSTON and then several of the visitors were called on. The words of greatest interest were spoken by Sir LOWTHIAN BELL, who told how 16 years ago he had visited the Birmingham district and had then predicted that probably the State of Alabama, with possibly the States of Tennessee and Georgia, would become the greatest center of cheap pig iron production in the United States. This prediction he had made on account of the juxtaposition of coal, iron ore and limestone in the South, while in the North these minerals require much transportation to concentrate them for iron manufacture. Next in interest were the speeches of Messrs. ALEXANDER THIELEN and P. C. GILCHRIST, each of whom declared his belief that the South could and would make basic steel from her phosphoric pig iron, a statement which greatly delighted the Birmingham men.

THE BIRMINGHAM DISTRICT—HOW THE MINERAL RESOURCES ARE DEVELOPED.

Having shown the visitors the wealth of the Birmingham district in iron ore, coal, and limestone, the reception committee devoted the second day to an exhibit of the extent to which these resources have been made use of. The excursion trains made their first stop at Bessemer. Here two 125-ton furnaces of the Debardeleben Coal & Iron Co. were visited

and also the plant of the Bessemer Rolling Mill Co. At this place seven trains of rolls and 24 puddling furnaces are at work, turning out finished bar iron of various sections, and rolling also sheet steel from the basic steel plant of the Henderson Steel Co. The machinery here is fairly modern, and can turn out a good grade of material. A battery of gas producers supplies fuel to the heating furnaces, and a corrugating department is one of the features of the works. The labor employed for the puddling furnaces and at the rolls is white; but negroes are used as common laborers and helpers, here as everywhere. The mills have a ready market for every pound of material they can roll. The South has a superabundance of raw materials and of pig iron; but as for the materials in further stages of manufacture she is still obliged to depend largely on the North.

About a mile from Bessemer the train stopped again to give the excursionists a chance to visit the coal mines and coke ovens of the Woodward Coal & Iron Co. The two furnaces here are 17 × 75 ft., with a daily capacity of 125 tons each. The stock used is a mixture of brown and red ores. The coke ovens are close by the furnace.

The next plant visited was at Ensley, 5 miles west of Birmingham. At this point is the largest furnace plant in the South, owned and operated by the Tennessee Coal & Iron Co., consisting of four 80 × 20 ft. furnaces, with 16 stoves and 12 blowing engines. The total cost of the plant was $1,276,000. During 1889 the total product is given as 144,426 tons, or a little less than 100 tons per day per furnace. It is claimed that a much better record can now be made. This product, however, netted a profit of 22% on the investment, or nearly $2 per ton of iron produced. The average cost of making pig iron at these furnaces is said to be $9.25 per ton.

Within a mile of the Ensley furnaces are two openings of the Pratt mines, also owned by the Tennessee Coal & Iron Co. Both these mines were visited and a number of the party made the descent. These mines are worked by convict labor, and there was much curiosity to see these men and inspect their quarters. The latter were found to be much better than is commonly understood, and it is said much better than they were until a year or so ago. The quality of the coal mined by the convicts is, as a rule, considerably inferior to that mined by free labor.

The next place visited was Thomas, where two excellent furnaces, the best equipped, perhaps, of any in the Birmingham district, were examined. These furnaces have an automatic charging apparatus, which is giving great satisfaction. The stock is loaded on small cars with drop bottoms and these are drawn up an incline to the top of the stack and discharged automatically just at the center, thus insuring equal distribution. The entire apparatus is worked by one engineer, and no time is wasted by the laborers in ascending to the top of the stack.

The last plant visited for the day was the Henderson Steel Works, a small plant still in the experimental stage, for making steel by the basic process. The managers of the company claim that the patents on the basic process which they hold antedate those of THOMAS and GILCHRIST; and their process as now worked is practically the Thomas-Gilchrist process, with the use of fluor-spar as a flux.

They claim to have made steel ingots at a cost of $20.60 per ton, recently, using in their charge a pig-iron costing $10.50 per ton and carrying 0.68% of phosphorus. The steel produced contained 0.018 phosphorus. The ingots are at present rolled at the Bessemer rolling mills, but it is hoped to erect a blooming mill and a plant of several furnaces at an early date. From this point the party was taken over one of Birmingham's numerous dummy railways to the Union Station. A small party which had gone to the Champion brown ore mine, 40 miles northeast of Birmingham, returned early in the evening; and soon after the excusionists bade goodbye to Birmingham.

EAST ALABAMA—THE BROWN ORE DISTRICT.

When the members of the party slid out of their berths on Saturday morning their trains were standing at Shelby Iron Works, the most southern point reached by the excursion, and distinctly the most typically tropical town seen. A row of whitewashed negro cabins stood opposite the trains, their front stoops ornamented with children of all shades and sizes, while dogs, pigs, and various other live stock lent additional animation to the scene.

Sugar cane was being sold by a peddler, a captive 'possum was on exhibition, and a crowd of white and colored people of both sexes and all ages stood about and talked with the strange-speaking foreigners, each party being to the other a curiosity worth careful examination. The proper study of mankind is man; and at Shelby the crowd about the trains, and the negro huts interested the excursionists far more than the iron works.

The latter, however, are of considerable historical interest. The Shelby works were among the earliest built in the South. When the war came the Confederates took the works and turned out a great quantity of excellent gun-iron until near the close of the war when a raiding party from SHERMAN'S army penetrated to this point and destroyed the works, which consisted at that time of a single charcoal furnace. The present plant consists of two small charcoal furnaces making about 110 tons of iron per week. The ore is brown hematite, and the hill containing the deposit, a few rods back of the furnaces, has been excavated in great cuttings 75 ft. deep or more and extending in various directions. An excellent ore washing plant, in which the ore is moved down the washing sluice by spiral blades on a longitudinal shaft, is about the only modern feature of the plant.

All Saturday afternoon was spent in making the run from Shelby to Anniston, less than 100 miles, if it could be properly called a run. The day was a perfect one, however, and the country passed through was such a novelty to the travelers that they found much to interest them. It was, indeed, an inspiring sight when the train pulled up to see grave gray-headed Britons and Teutons dash out into the fields and pluck a branch of the cotton plant or some ears of the Southern horsetooth corn, or even chase after some gay butterfly. At Talladega the party stopped to look at a furnace in which some British investors have sunk a good sum of money, from which the returns have not yet come to hand. The furnace uses brown hematite, as do all the furnaces in this district, and makes an iron lower in phosphorus than the Birmingham iron, but not enough lower to compensate for the added cost of production.

At the Anniston Pipe Works the train made a brief stop. The works have a capacity of 200 tons a day, and turn out pipe up to 36 ins. in diameter. The works have the advantage of cheap iron and also of short haul in competing for Southern trade. Two 100-ton furnaces of the Woodstock Iron Co., just out of Anniston, were next visited. These were out of blast, it is said because they cannot make iron in competition with the Birmingham district, and, as stated for the Talladega furnace, while their product may be of a higher grade, it is not enough better to compensate for its greater cost.

At Anniston the party stayed from 6 o'clock until late in the evening. Anniston impresses one as a delightful place for a residence. Its numerous beautiful buildings and comfortable residences, its location among the hills, its busy and prosperous aspect, are all attractive to a Northern eye. Some of the party took a carriage drive about the town, through the courtesy of the local committee; others feasted at the Anniston Inn, and others visited some of the manufactories.

A prosperous car building plant is operated here by the United States Rolling Stock Co., and is now being enlarged to a capacity of 20 cars per day. The advantages of a car building plant in the South are that it can purchase lumber cheaply, and can save freight on cars delivered to Southern roads. Cast iron ought also to cost less than in the North, but there is said to be a sort of tacit understanding among the furnace men to "charge what the traffic will bear." The wheel foundry at these works is to be remodeled soon, and the Whiting system of overhead trolleys, invented by the Superintendent of the Detroit Wheel & Foundry Co., is to replace the old jib cranes worked by hand. With this plant completed car-wheel manufacture ought to pay well here, for the iron of the Anniston district is well adapted to car wheels. The works have much difficulty in getting wrought iron to supply their needs, and a rolling mill department is now being added.

LOOKOUT MOUNTAIN.

Most of Saturday night the excursion trains lay at Dalton, Ga., held there by a derailment of the engine of one of the sections, followed by a break-in-two. So Sunday morning was well advanced when the trains reached Chattanooga. Here great preparations had been made for their reception. The local committee was in waiting, and under their direction the transfer was made to the cars of the Lookout Mountain Ry. It is safe to say that however many features of American furnace practice the visitors forget, they will not forget that Sunday morning ride up Lookout Mountain. The road is a standard gauge line with a uniform grade up the mountain of 1¼%. There is one switchback about half way, and here the up and the down trains pass each other. At the end of the journey the traveler is landed on the top of the mountain at Lookout Inn, 1,700 ft. above the Tennessee River. On such a perfect autumn day as that which it was the good fortune of the party to spend on the mountain, the beauty and grandeur of the view from the summit are beyond description. Not the least charm of the mountain and its long, low, neighbor, Missionary Ridge, lying five miles to the southeast, is the memory of the stirring scenes which were enacted upon their flanks a quarter century ago. On Sunday afternoon the whole party assembled on the precipice known as Lookout Point, from which a fine view of the battlefields is obtained, and Gen. J. T. WILDER, the first Union general to enter Chattanooga with his troops, explained the campaigns and battles which took place in 1863 in the country overlooked from the point. In the evening some of the German members entertained the party with singing in the pleasant parlor of Lookout Inn, and Gen. WILDER, who was the first man to make pig iron with coke in the South, explained the chief features of the Chattanooga mineral district.

CHATTANOOGA.

On Monday morning all except the timid members of the party came down the mountain via the narrow gauge and the cable incline railways. The latter road (illustrated and described in ENGINEERING NEWS, Jan. 7, 1888) drops its passengers from Point Lookout down the mountain side a vertical distance of 1,168 ft. in 4½ minutes. It is a three-rail line, the up and the down cars passing each other at the center, where for a short distance four rails are laid. The cars are equipped with automatic brakes, which in the event of a breakage of the cable clasp against the head of the rail. Electric connections permit the conductor to signal the engineman at the power station and order the car stopped at any point.

From the foot of the incline, cars of the Chattanooga Union Ry. took the excursionists to the Chattanooga pipe works. There are four casting pits here, two of which are of the design patented by President GILES, of the company. On these pits the central platform, including the bench on which the flasks rest, is mounted upon a circular track, so that it can be turned to bring any section adjacent to the point where the cores are made or the melted iron is poured. These pits have been in use for about 3 years, and are found to save time and labor and keep the foundry in good order. The company is building new works at Bridgeport, Ala., on the Tennessee River, 12 miles below Chattanooga, where two of these revolving pits for casting 33-in. and 48 in. pipe will be put in.

A short tour was made through the oak bark tannery of Fayerweather & Ladew, claimed to be the largest in the world. From 300 to 400 hides a day are turned out, all the best part of which is used for belting. Then the train went on to the works of the Southern Iron Co., where a small plant has been recently put in operation making steel by the basic process. Up to Monday morning, Oct. 21, the total number of heats made was 22. The pig iron used comes chiefly from the furnaces at South Pittsburg, and has about 0.85% of phosphorus. The product carries about 0.07% of phosphorus, the same amount of carbon, and about 0.45% manganese. The steel thus far turned out has not been rolled, but appears to be of poor quality, due almost certainly to the use of pig iron containing too much sulphur and silicon. However, with the demand for a pig iron suitable for the basic process, there seems every probability that it will be produced from Southern ores, and with the use of this in open-hearth furnaces of so good construction as those set up at Chattanooga there need be no trouble in making good steel. One furnace only, of 30 tons daily capacity, has been completed, but a second is nearly finished, and six more are to be built soon. A blooming mill is now being set up to work the ingots into merchantable material.

From this point the party walked a short distance to the river bank and took a steamboat for a short trip up the river. Among the points of interest passed on the way were a new highway bridge across the Tennessee River, which is now receiving the finishing touches. The contractor is the Smith Bridge Co. and the chief engineer is EDWIN THACHER, of Louisville. Farther on is the Citico furnace and the pumping and filter plant of the city water-works. The filters are of the mechanical type, and some idea of the amount of sediment carried by the Tennessee River at its higher stages may be gathered from the statement that when the water is especially muddy as much as 25% of the water pumped is used towash the filter.

In the afternoon the excursionists divided. The larger number were taken over the dummy railway to the National Cemetery where 13,000 soldiers are buried. From this point by the dummy and electric lines a trip was made to the top of Mission Ridge, and this site, where one of the most hotly contested battles of the war was fought, was viewed with great interest. Gen. J. T. WILDER accompanied the party and explained the military movements which took place in 1863.

A smaller party spent the afternoon in a trip to the Sequachee Valley in a special train over the Nashville, Chattanooga & St. Louis Ry. At South Pittsburg the pipe works were visited, and a careful examination was made of the furnace plant of three stacks, owned by the Tennessee Coal, Iron & Railroad Co. One of the furnaces has been out of blast for six months, but is soon to be blown in again. Pig iron has been made here at a price as low as $10 per ton, and $11 may be taken as an average. The ore used is a mixture, about five-eighths of which is a hard red ore mined at Inman and brought to the furnaces at a cost of 25 cts. per ton. The coke is partly from Whitwell, 15 miles further up the valley, and partly from the Tracy City mines, about 50 miles distant by rail. The former costs about $2 and the latter $2 30 at the furnace. About 3,100 lbs. of coke is used per ton of iron of 2,240 lbs. The iron costs somewhat more to make than that in the Birmingham district, but the advantage of having water transportation to market, South Pittsburg being on the Tennessee River, offsets this to a large extent. About 100 tons per day of the output is taken by the pipe works and stove works at South Pittsburg, and the new pipe works at Bridgeport already mentioned will absorb another considerable amount.

The trains which carried the excursionists left Chattanooga at 9 P. M., hence the informal reception which was tendered to the visitors in the evening at the Chattanooga Chamber of Commerce was very brief. A darky chorus in the trainshed amused the excursionists until the trains pulled out, and everybody crept into their berths with grateful memories of two pleasant days at Chattanooga.

Electric Motor Power Technically Considered.

The report of the committee on "Electric Power Technically Considered," read by Mr. WILLIAM L. ALLEN at the Buffalo meeting of the American Street Car Association, is valuable as coming from the standpoint of the manager and operator of lines rather than from the maker of motors. Want of space unfortunately forbids the publication of the report in full, but the following abstract gives the salient points of the document.

In regard to work performed at the power stations, there are points of material difference between electric lighting and electricity as applied to street car motors. In the latter case the engine must be strong in all its parts, as the demands vary frequently from the entire absence of load to the extreme capacity. In the case af a road operating eight cars of 5 HP. each, with one 150 HP. engine in the station, the cars may become bunched or happen to start at the same instant; here, a sudden demand may be made upon the engine for 150 to 200 HP., while a moment later the meter may register but 40 HP. Safety plugs and current strips are provided, of course, but the operators of the road can not afford to have them blown out half a dozen times a day.

In electric lighting a number of small high-speed engines is deemed more economical and flexible in operation; but while the load upon these light producing engines varies gradually, the power engines may be called upon at any moment for their maximum duty. The arrangement of the power stations to meet this demand, and to avoid at the same time operating a heavy engine for an average light load, is a problem yet to be solved.

The overhead system of transmission of power is the most popular for its simplicity, cheapness, durability and convenience. Curves are troublesome, owing to the jumping of the trolleys at some sharp angle; but the trouble is generally due to faulty trolley-stands, etc., rather than to the wires. There is little improvement to be asked for in overhead material as provided by the Thomson-Houston, Sprague-Edison or Westinghouse systems. Choice can be taken and the results will be equally good. It will often be convenient to combine the heavy wire for central parts of a city, where a single wire would be least objectionable, with a small overhead and feed wire to reinforce the suburban parts of a line. The small wires are more easily handled and repaired, and the feed wire prevents a dead line as the result of a break. The rail bonds may be galvanized iron, costing 4 cts., instead of tinned copper, and the supplemental ground wires can be of the same material. Rails on both sides of the track should be connected with bonds, and the supplemental wires give no better results except that they prevent a bad break in the return circuit in case of breaking of both rail bonds at neighboring joints.

The committee does not concede the need of conduits or storage batteries, as far as the operator is concerned. The public may deem poles objectionable, but the operator's constant problem is to keep his motors out of the repair shop; he does not worry about his station or overhead system. The operator wants a wide and properly heavy gear and pinion, and material in these that is reasonably durable and at the same time noiseless. Cast-iron may do for the axle-gear, which is large and runs slow, and steel would seem to be cheaper and better than bronze for the intermediate shaft pinion. To overcome the noise, the gear may be covered and run in oil; or the gear may be wood and the pinions of raw hide. All keys in gear and pinion should be tight and self-containing. The shaft-boxes should be of some compound metal that will not wear out too fast and permit the armature to scrape the pole pieces on the motor. Aluminum bronze gives satisfaction for the armature bearings.

The armature of an electric motor is its most wonderful and interesting, as well as its most expensive and troublesome part. A number of well-known causes may require of an armature more work than it is capable of performing, hence a burn-out. On the other hand, the armature itself may be at fault. The shaft of the armature will, in a few years, become worn by its bearings, and it would be well to have bushings or sleeves placed around shaft at those points, such as the Thomson-Houston Co. use, which sleeves can be removed. As there is no wear to the core, and as the commutator can be renewed when worn down, which ought not to occur in less than two or three years, an armature should then have as long life as one could desire were it not for the coils of wire. Where these coils cross around the head of the armature they chafe on each other and destroy their isulation. Where they end in the commutator they loosen; by an excessive load or careless driver they burn-out. It may be possible to repair the armature by rewinding one coil or by refastening the loose ends, and even when a deep coil is burnt the total rewinding with new wire should not cost but $40 or $50. The gear and bearings can be watched, and when worn they may be replaced at convenience or at night, but an armature gives out without warning. It is on this account that those systems advocating but one motor to a car must give positive assurance of *no burn-outs*.

The switch-box, such as used by the Sprague-Edison and Westinghouse, is an apparatus that, if given proper care, so as to keep the brass plates and buttons smooth, ought not to cause much trouble. It is arranged so as to distribute the current through different parts of the magnets or the motor according to the degree of speed or work required. It is somewhat in the way of passengers when the platform is overcrowded. The rheostat used by the Thomson-Houston Co. is out of the way, being underneath the platform, although it is burnt out occasionally and damaged by rain leaking through the platform; these defects should be easily overcome. It is claimed that owing to the use of the rheostat of the Thomson-Houston Co., and the resistance coils as used by the Westinghouse Co., that the cars start much more easily and without jerking, and that the motor is less liable to burn out, as they avoid throwing in an excess of current. The first claim is true, but the committee cannot find evidence to support the latter claim. On the other hand, it has been claimed that motors using a rheostat require on an average run from 15% to 20% more power than the Sprague-Edison motor. It does not necessarily follow that this is due to the rheostat; it seems likely that it is due as much to a difference in the winding of armature or fields. It would be most desirable, therefore, to ascertain from various members the actual number of burn-outs of fields and armatures of both varieties of motors, and at the same time the average power used per car. This cannot be obtained by writing for reports, as many roads do not keep an exact record, or will not report the same. The grades of roads must be considered, the car mileage and loads carried, also the system or manner with which motors are repaired and cared for.

This is a matter of the greatest importance. Fuel costs about $1 per car per diem, and repairs over $1.50 per car per diem. If 10% each day can be saved by giving up the rheostat, it should not be done at the expense of adding 25% to repair account, too large already. As an example of the approximate cost of repairs, the cost is given of four 30 HP. Sprague cars for the six months ending Oct. 1, 1890, each car making 90 miles a day, with a grade of 1,900 ft. of 9 to 9¾%, one 300 ft. of 5%, one 300 ft. of 8%:

MECHANICAL.	
3 Bronze intermediate pinions, at $14	$42.00
3 Steel " " at $9	27.00
8 Steel armature " at $7	56.00
4 Intermediate gear, at $11	44.00
2 Main gear (axle), at $16	32.00
6 Axle brasses, at $4.50	27.00
8 Shaft bearings, at $4.50	36.00
12 Armature bearings, at $2.75	32.00
Total	$296.00
ELECTRICAL.	
180 Carbon brushes at 10c	$18.00
6 Trolley wheels, at $1.25	7.50
3 Field magnets, at $20	60.00
6 Armatures repaired, at $35	210.00
	$295.50
LABOR.	
2 Motor repair men, at $50 per month	600.00
Total	$1,191.50

Average per diem per car, $1 62. There are other minor repairs that would increase this about 20 cts. a day. Fuel, sawdust and slabs, $1.30. This fuel is about equal to screening or slack at $1.50 a ton. A greater number of cars would reduce this fuel account per car. During the six months the expense on the overhead line was less than $25 on 5 miles of line. The prices for gear and bearing will vary considerably from those given above. Some axle brasses cost $9, while those above are given at $4.50. Aluminum or some such compound may be mixed and used to decrease the cost and increase the durability of bearings. It was sold a few years ago at $3 and upward per pound, now at $1, and it is stated can be produced for 20 cts. per pound.

In the matter of gear the Westinghouse Company has so boxed the same that it can run in oil and grease; this must undoubtedly add much to the life of the gear and pinion, and at the same time practically deaden the noise. Whether this boxing will stand the wear and jar time will best demonstrate.

As showing the proportion of cars disabled from electrical and mechanical causes, the report concludes with the following return from a road operating Thomson-Houston motors: During 14 consecutive days in July, 1890, there were 286 cars equipped and from 150 to 200 operated. Out of these 26 cars were electrically and 158 mechanically disabled. In 7 consecutive days in August 308 cars were equipped and 158 cars operated; 17 were electrically and 55 mechanically disabled. During 7 consecutive days in September 312 cars were equipped and 150 cars operated; of these 15 were electrically and 24 mechanically disabled.

From this it appears that in July about 1% of cars operated were disabled each day from electrical causes and about 6% from mechanical causes, and this during a period of extraordinary heavy business. During the August period the electrical trouble appears to have increased slightly in excess of 1% and the mechanical decreased to about 5%, and in September the mechanical trouble decreased to about 2%. This decrease was probably due, in some

degree, to a lighter business and less mileage. As the report does not state the nature or degree of the electrical disabilities, it is not fair to assume that they were all due to crippled armatures, but we can deduce from it that a car ought to run 100 days without electric repairs.

Compound Locomotive Trials in France.

The *Schweizerische Bauzeitung* gives records of the tests of a Mallet 4-cylinder compound locomotive, with movable forward truck, tested in comparison with some locomotives of the usual type with 6 coupled drivers and a rear pony truck. The compound engine, which weighs about 26.4 tons, was built by the *Société Alsacienne de Construction*. The tests took place on a French military railway, with a 3.37 ft. guage:

	Simple Locomotive.	Compound Locomotive.
Weight of trains hauled	36,520 tons.	42,350 tons.
Train miles	26,462	13,808
Ton miles	972,500	587,250
Average tons per train	36.7	42.5
Total consumption of coal	700,815 lbs.	339,229 lbs.
Coal burnt per mile	26.3 "	24.35 "
" " " ton mile	0.97 "	0.688 "
Saving per mile		7.24 per cent.
" " ton mile		19.92 " "

Another set of trials gave the following results:

	Simple Locomotive.	Compound Locomotive.
Weight of trains hauled	33,000 tons.	38,830 tons.
Coal burnt per mile	19.57 lbs.	17.1 lbs.
" " " ton-mile	0.57 lbs	0.438 lbs.
Saving per mile		9.4 per cent.
" " ton-mile		23.0 per cent.

On 25 per cent. grades the simple engine drew a train of 66 tons, the compound locomotive drew one of 99 tons, or 1.5 times as heavy, at the same speeds. It is obvious, however, that compounding could not be the cause for this, in any true sense. The weight of the train with a compound engine amounted to 26.4 + 99 = 125.4 tons, with 450 sq. ft. of heating surface; the weight of the train and simple engine came to 24.2 + 66 = 90.2 tons, with 419.4 sq. ft. of heating surface. Hence the compound locomotive drew a train 39 per cent. heavier, or, if we take into account the difference in the heating surfaces, 30 per cent. heavier.

PERSONAL.

Mr. E. K. TURNER, Chief Engineer of the Fitchburg R. R., has resigned.

Mr. L. S. MILLER has been appointed Chief Engineer of the St. Paul & Duluth R. R., vice Mr. C. A. F. MORRIS.

Mr. C. W. LEE has been appointed Master Mechanic of the Richmond & Danville R. R. shops at Salisbury, N. C.

Mr. ABRAM S. HULL, for 34 years Master Mechanic of the Cumberland Valley R. R., died recently at Chambersburg, Pa.

Mr. CHARLES E. PARKER, one of Boston's most prominent architects, died at Newport News, Oct. 26, at the age of 64.

Mr. E. T. MEISTER has been appointed Roadmaster of the Delaware Division of the New York, Lake Erie & Western R. R.

Mr. W. H. VAUGHAN has been appointed Superintendent of Transportation of the Pecos Valley Ry. with headquarters at Eddy, N. M.

Mr. J. F. ANGELL has been appointed Superintendent of the Toledo Division of the Toledo & Ohio Central R. R., with headquarters at Bucyrus.

Mr. M. H. MILLS has been appointed Assistant Superintendent of the Montana Division of the Northern Pacific R. R., with headquarters at Livingston, Mont.

Mr. J. P. BRADFIELD has been appointed Superintendent of the Buffalo Division of the West Shore R. R., and Mr. W. G. WATTSON Superintendent of the Hudson River Division.

Mr. CORNELIUS PALMER has been appointed Engineer of the Peninsula Division of the Chicago & Northwestern Ry., in place of Mr. S. H. SELDEN, resigned on account of ill health.

Mr. L. K. SAFFORD has been appointed Superintendent of Bridges, Buildings and Water Service on the Kansas City, Fort Scott & Memphis R. R., with headquarters at Kansas City, Mo.

Mr. H. C. BOUGHTON has been appointed Assistant Superintendent of the Cincinnati Division of the Chesapeake & Ohio Ry., with headquarters at Cincinnati, O., in place of Mr. W. J. MCKEE, resigned.

Prof. HENRY T. EDDY has accepted the Presidency of the Rose Polytechnic Institute at Terre Haute, Ind. Prof. EDDY has been connected with the Cincinnati University for 16 years, and was recently chosen its President.

Mr. WILLIAM HELM has been appointed City Engineer of Newport, Ky., taking the place of the late C. L. JUNGERMAN. Mr. HELM is quite a young man, and has been Assistant in the Newport engineering corps for some time.

Mr. G. W. BATES, who for 13 years has been Foreman of Bridges and Buildings on the Wabash R. R., was recently appointed to a similar position on the Cleveland, Cincinnati, Chicago & St. Louis Ry., with headquarters at Crawfordsville, Ind.

Mr. G. R. CARR has been appointed Superintendent of Construction of the Pittsburg & Lake Erie R. R. He was at one time General Superintendent of the Columbus, Hocking Valley & Toledo Ry., and more recently was connected with the Hocking Western R. R.

J. SEABURY O'DWYER, C. E., late Assistant Engineer C. P. R. R., Montreal, has formed a partnership with R. E. PALMER, C. E., and the new firm has opened an office at 237 Cordova St., Vancouver, B. C., as civil engineers, dominion and provincial land surveyors.

Mr. J. A. DAVENPORT has been appointed Engineer of Maintenance of Way on the division of the Central R. R. of Georgia extending from Atlanta to Birmingham, and Mr. J. C. MOTLEY has received a similar appointment on the division from Birmingham to Columbus, Miss.

HENRY WARD POOLE, civil engineer and scientist, died in Mexico on Oct. 14, aged 64 years. Mr. POOLE was born in Salem, Mass.; located and reported on coal lands on the Pacific coast in 1856, and soon after established himself in Mexico and there remained until his death.

Mr. W. F. TURREFF. Superintendent of Motive Power of the Cleveland, Cincinnati & St. Louis Ry. has resigned. Mr. TURREFF was General Master Mechanic of the Cleveland, Columbus, Cincinnati & Indianapolis line before its consolidation with the Big Four, and was formerly for 6 years Master Mechanic of the Cleveland, Tuscarawas Valley & Wheeling road.

Messrs. EDWARD COOPER and JAMES HARDMAN, civil engineers on the New York & New Haven R. R. were run over and killed Oct. 28 on the Niantic bridge at East Lynne, Conn. They were crossing the bridge and did not allow time enough for getting out of the way of an approaching train. Mr. COOPER graduated as a civil engineer from Cornell College, being one of the class of '85. For 2 years he served in the office of the Park Board of New York, and then went back to Cornell, where he received a post-graduate fellowship. He then resumed his service in the Park Department and about a year ago received an appointment as assistant engineer on the New York, New Haven & Hartford road.

NEW PUBLICATIONS.

—*Atlas of the Metropolitan District and Adjacent Country*, comprising the Counties of New York, Kings, Richmond, Westchester, and part of Queens, in the State of New York; the county of Hudson, and parts of the counties of Bergen, Passaic, Essex and Union in the State of New Jersey; showing in a series of maps the relative Geographical Position, the Topography, Hydrography and Economic features of this Area. From original surveys by J. R. BIEN and C. C. VERMEULE, the U. S. Coast Survey and the Geological Survey of New Jersey. New York, Julius Bien & Co. Large folio; 13 large maps and index maps, $20.

We sincerely trust that this magnificent work will meet with the success that it deserves, nor can we doubt that it will. High as is the price, it is much cheaper in proportion to value returned, than any other atlas which has ever come to our table. The maps are beautifully executed in several different colors, show the topography accurately both by contours and shading, and appear to be very accurate in all respects. Except the index map, which is on a scale of four miles to an inch, all the maps are on the uniform scale of two inches per mile, and so complete are they that the elevation and probable character in respect to surrounding surface of any lot on the entire area covered can be fairly well judged.

The scale employed admits of detailed illustration of the many economic features of interest within this area; all roads are indicated, the streets of the towns being named; the forestry, hydrography, and drainage are included, and a careful distinction of the fresh and salt water marshes is made. The contours on most of the maps are 10 ft. apart; they are 20 ft. apart on the others, and the general appearance of the country is skilfully brought out by shading, similar to that employed so successfully by the Royal Survey of Saxony. The size of each map is 23 × 35 ins., mounted on guards and bound; the atlas being 17¼ × 23 ins.

Such a publication as this would have been practically impossible to private enterprise except that a large part of the information required has been already gathered by public surveys. The State of New Jersey has been already accurately surveyed and mapped by the State Geological Survey; but these maps are on twice as large a scale and are artistically and practically an improvement, even on those remarkably handsome and invaluable maps. The Coast Survey work also covered a large part of the remaining area; but much of the ground covered by these maps had to be surveyed for this especial purpose, we are informed; and much of the rest had to be worked up from original notes or plates.

When we have become a little more wealthy and civilized, publications of this class will be made by the government and sold to the public at cost, we do not doubt, but in the meantime it is fortunate that private enterprise steps in to give us almost as good maps as could ever be desired for so important an area, and at a price which certainly is far from excessive.

SOCIETY PROCEEDINGS.

Polytechnic Society of Utah.—Organized April 18, 1890. Officers for 1890—President, CHARLES L. STEVENSON; Vice-President, R. H. TERHUNE; Secretary, M. S. Hanauer, Headquarters, Salt Lake City, Utah.

American Institute of Architects.—At the close of the Washington Convention of this organization this week the following officers were elected for the ensuing year: President, R. M. HUNT; vice-presidents, W. W. CORLIN and I. W. MCLAUGHLIN; secretary, JNO. W. ROOT, of Chicago; treasurer, S. A. TREAT, Maine. The next annual meeting will be held in Boston, Mass.

Engineers' Club of Philadelphia.—Record of business meeting, June 21, 1890, Vice-President Wilfred Lewis in the chair; 30 members and one visitor present. The Secretary presented for Mr. Robert A. Cummings an illustrated description of the subject of granolithic pavements, in which Mr. Cummings describes this form of pavement, giving European practice with regard thereto, etc., together with a table of tests of cement and granite dusts. There was some discussion of this paper by Mr. Edward Hurst Brown.

Record of business meeting, Oct. 4, 1890, President H. W. Spangler in the chair; 31 members and one visitor present. The Secretary presented a correspondence with regard to the participation by the club in the proposed International Congress of Engineers to be held during the coming World's Fair at Chicago, and moved that a committee of three, to consist of the President and two other members to be named by him, should be appointed to take up this subject so far as this club is concerned. It was so ordered.

Record of regular meeting, Oct. 18, 1890, President H. W. Spangler in the chair; 21 members and one visitor present. The Secretary presented, for Mr. Robert Robert A. Cummings, a photograph and description illustrating the effect of gases from locomotive stacks upon vegetation Mr. Arthur Falkenau presented an extensively illustrated description of a new method of making barrels by machinery. The drawings illustrating this description are of so elaborate a character that it would be impossible to give a comprehensive abstract.

HOWARD MURPHY, Secretary and Treasurer.

American Society of Mechanical Engineers.—Richmond convention, Nov. 11-14. The following programme is issued: The opening session of the convention will begin by an address of welcome by his honor the Mayor of Richmond, J. TAYLOR ELLYSON, followed by the annual address of President OBERLIN SMITH. In the evening a reception is tendered to the society by the Governor at the gubernatorial mansion. Wednesday A. M., business session—Committees' reports on Methods of Testing Materials, Methods of Duty Trials of Pumping Engines; Methods of Test of Locomotive Efficiencies, and on Uniformity of Flange Diameters. Papers by FRANK VAN VLECK, "Light Cable Road Construction;" R. H. THURSTON, "Authorities on the Steam Jacket: Facts and Current Opinions and Chimney Draft: Facts and Theories;" T. R. ALMOND, "A Novel Form of Flexible Tubing;" R. C. Carpenter, "Heat Transmission through Cast-Iron Plates Pickled in Nitric Acid." James River excursion in afternoon; luncheon served on the boat. Evening session. Papers by DE VOLSON WOOD, "Some Properties of Ammonia;" "Mechanical and Physical Properties of Sulphur Dioxide (SO_2), and "Theoretical Investigation of Efficiency of Vapor Engines;" D. S. JACOBUS, "Experimental Determination of the Latent Heat of Ammonia;" JAS. MCBRIDE, "Automatic Regulation of Injection Water to Vapor Condensers." Closing with topical discussions.

Thursday morning. Papers by LOUIS G. ENGEL, "Hydraulic Hoisting Plant for the Pier of Brooklyn Sugar Refining Co;" ERWIN GRAVES, "Hydraulic Traveling Crane;" W. A. BOLE, "The Single Acting Compound Engine;" C. W. HUNT, "Rope Driving;" JNO. H. COOPER, "Accident Preventing Devices for Machines;" AMBROSE SWASEY, "New Process for Generating and Cutting the Teeth of Spur Wheels;" GEO. W. BISSELL, "An Interesting Experiment with a Lubricant;" JAS. E. DENTON, Performance of a 75-ton Refrigerating Machine of Ammonia Compression Type, and Some Novel Experiments with a Lubricant." Closing with topical discussions.

Carriage drive in the afternoon; reception by the citizens of Richmond in the evening.

Friday morning, special train tendered by Chesapeake & Ohio Ry. to the yards of the Newport News Ship Building Co., where luncheon will be served. From there the Atlantic & Danville Co. will take the party by their boats to the Portsmouth Navy Yard and to Norfolk.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.

Vol. XXIV. Saturday, November 1, 1890.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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Advertising rates, 20 cents per line *agate measure. Schedule sent on request.* **Changes** *of advertisements must be in hand on Tuesday afternoon;* **New** *advertisements Wednesday afternoon;* **Transient** *advertisements not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty, or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia.—Next meeting, Nov. 1. Secy., Howard Murphy, 1122 Girard St.

Civil Engineers' Society of St. Paul.—Next meeting, Nov. 3. Secy., G. L. Wilson.

Western Society of Engineers.—Next meeting, Nov. 4. Secy., J. W. Weston, 280 La Salle St., Chicago.

Civil Engineers' Club of Cleveland.—Next meeting, Nov. 4. Secy., A. H. Porter, 50 Euclid Ave.

Denver Society of Civil Engineers.—Next meeting, Nov. 4. Secy., Geo. H. Angell.

Engineers' Club of St. Louis.—Next meeting, Nov. 5. Secy., W. H. Bryan, 30 South 7th St.

American Society of Civil Engineers.—Next meeting Nov. 5. Secy., John Bogart, 127 E. 23d St., New York.

Civil Engineers' Association of Kansas.—Next meeting, Nov. 5. Secy., J. C. Herring, Wichita, Kan.

Association of Civil Engineers of Dallas.—Next meeting, Nov. 7. Secy., E. K. Smoot, Elm and Austin Sts.

Technical Society of the Pacific Coast.—Next meeting Nov. 7. Secy., O. von Geldern, 408 California St., San Francisco.

Engineering Association of the Southwest.—Next meeting, Nov. 13. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Engineers' Club of Minneapolis.—Next meeting, Nov. 13. Secy., F. W. Cappelen.

Western Railway Club.—Next meeting, Nov. 18. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery, Bldg.

Boston Society of Civil Engineers. Next meeting, Nov. 19. Secy., S. E. Tinkham.

New York Railway Club.—Next meeting, Nov. 20. Rooms, 118 Liberty St.

Engineers' Club of Cincinnati.—Next meeting, Nov. 20. Secy., J. F. Wilson.

Engineers' Society of Western Pennsylvania.—Next meeting, Nov. 21. Secy., S. M. Wickersham, Pittsburg, Pa.

THE editors of this journal desire to secure an engagement with some party in the field, preferably an engagement which can be permanent on some railway in the North Central or South Central States for the son of a late eminent engineer, universally known and respected. The young man has as yet had little experience, but is believed to lack nothing but experience to do credit to the name he bears.

ON another page in this issue will be found several solutions of the problem in surveying proposed by Mr. F. HODGMAN in ENGINEERING NEWS, Aug. 16, 1890. The first five among the nine correct answers are so excellent that it is no easy matter to choose the best, no one excelling in all points. On the whole, however, we judge Mr. STEIGER's method to be most practical, being most easily comprehended and least liable to error in working out.

The small percentage, barely 25 per cent., of correct solutions, or 9 out of nearly 40, is rather astonishing. The problem seems to us to have been fairly stated; in very much the same way, and with about the same explicitness, as it would have presented itself in practice upon the ground. The point on which most failed was in not seeing that the difference between the new and original surveys was due to differences both in magnetic variation *and* in the chains used. The proof of this fact is clearly made in Mr. STEIGER's general solution. It was in no respect the duty of the proposer of the problem to distinctly call attention to this fact.

THE excursions of the British Iron and Steel Institute and the *Verein Deutscher Eisenhuettenleute* in the United States were concluded this week; and many of the visitors are already making their return passage across the ocean. The entertainment provided for the members of these societies during their month's stay in this country has been without precedent either here or abroad. The work of entertaining our guests has not been without certain unpleasant incidents, but these are best forgiven and forgotten, as we trust have been any lapses from gentlemanly behavior which may have occurred among the American engineers who were so hospitably entertained in England and Germany last year. The members of the *Verein Deutscher Eisenhuettenleute*, with scarcely an exception, were especially notable for their interest in the works visited, and their patient tolerance of the inevitable mischances of travel; while their evident appreciation of the courtesies tendered them won them friends everywhere.

THE conductors of the excursions are to be congratulated on their success in taking so large a party over so long a journey with so many unusual sources of danger, and bringing back every member safe and sound. The fact that the party was carried throughout in special trains, run in sections, and that the travelers were unfamiliar with American cars, and were jumping on and off the trains at all sorts of places, sometimes when the trains were in motion, makes the freedom from fatality very fortunate. Some of the party, indeed, narrowly escaped paying a severe penalty for various rash acts.

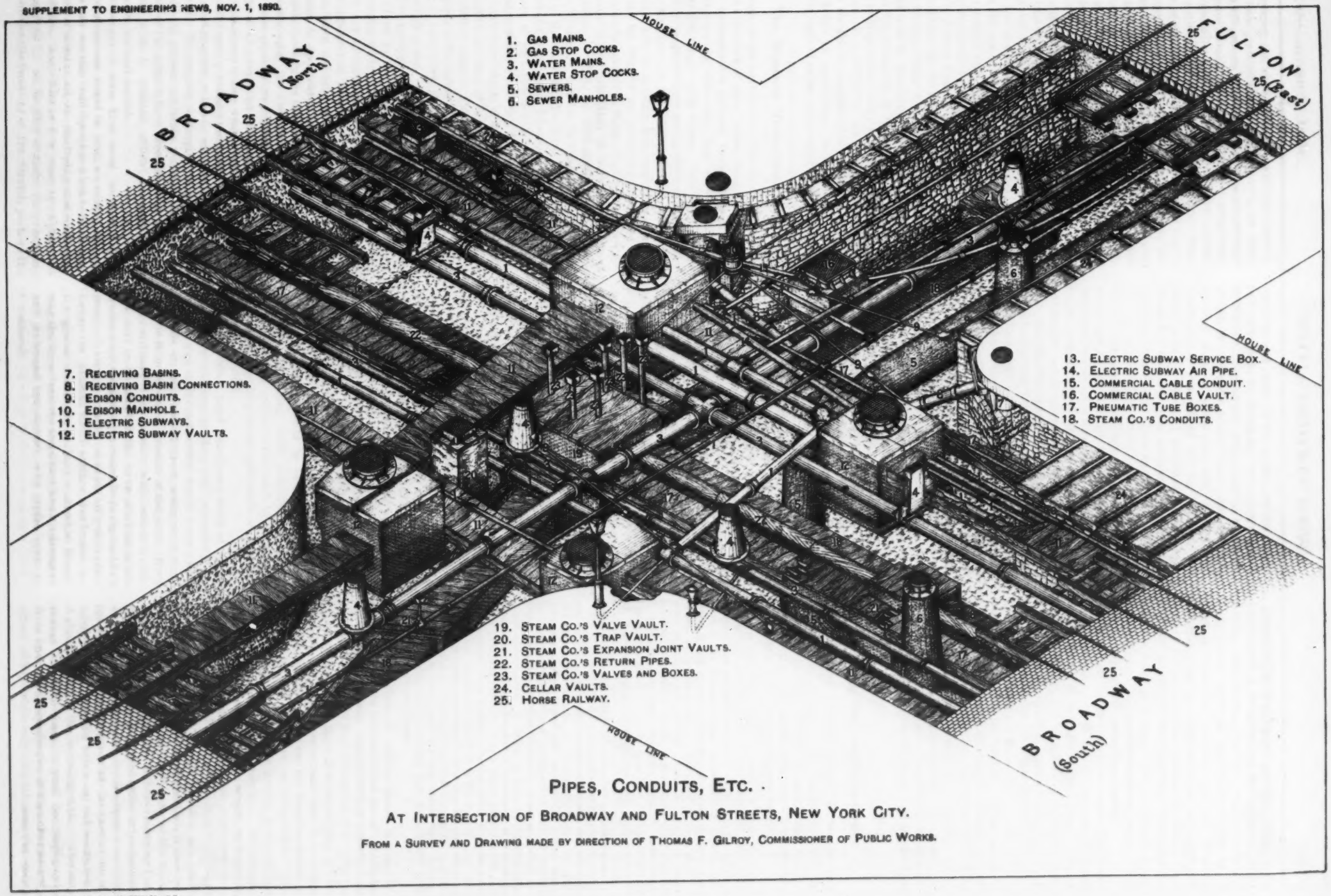
The Southern railway managers are deserving of especial credit, for they not only disorganized their regular traffic to a considerable extent to haul the excursion trains, and took especial precautions to insure their safety, but they made no charge whatever for the service. It was because of this generosity that the reception committee were able to give the visitors so extended a trip through the South.

THE impression which the tour through the country appears to have made upon the visitors is in general that our natural resources are far superior to those of either England or Germany. The great development of iron and steel manufactures in the North is, in many respects, superior to that of our foreign competitors, as many of them have freely acknowledged. As might be expected, American methods and appliances aim at encouraging labor, where the energy of European engineers is devoted to saving material. It is this which has led the vistors to characterize some of our practice as wasteful. Under the rapidly changing conditions of the present day—advancing wages abroad and natural resources becoming more valuable here—it is likely that each party can profit by copying somewhat from the other's practice. The excursion on the whole has been a rather remarkable one, in view of the fact that it was purely an expression of national courtesy, the hosts having no possible selfish motives, for the visitors are our competitors and are not likely, under any circumstances, to be our patrons, at least for many years to come.

THE Institution of Civil Engineers has issued its usual annual list of 50 or more subjects on which papers are invited, preceded by the very liberal list of premium funds which they have available, aggregating not less than $2,250 per year, $750 of it for students only. The contrast between this handsome sum and the total of $100, which the Am. Soc. C. E. has to dispose of, is very notable, and another of the many evidences that our own society is not yet the live institution which it should be. The subjects proposed relate to almost every technical question now open, but are expressly stated to be suggestive only, papers being invited on any subject, and from natives or foreigners, members or non-members alike. It does not often happen, we believe, that papers of importance are actually received from others than members in response to this invitation, but the spirit shown by it is admirable, and must in one way or another have its effect.

WE are pleased to note that that admirable electrical journal, the *Electrical Engineer*, has joined the great majority of American technical journals and technical men in styling the latest addition to the list of cheap and useful metals aluminum, and not aluminium, which latter designation it had previously been using, and which latter is still, we regret to say, the more common form in England. That a change will come soon there also we cannot doubt. Reason, analogy, euphony, the history of the metal, the practice of all the large manufacturers, the genius of the language, which strongly leans toward the shortest form for all words in common use, all favor the shorter term. Unfortunately, chemists, naturalists and such like folk have rather a leaning the other way, toward using the longer form of any name when there is a choice, as seeming the more scientific and abstruse. While the metal was a mere chemist's curiosity, they had their way unchecked, and so managed to interpolate another syllable into a word used only by themselves. Now that it is coming into common use, it is becoming already clear that this unwarranted interpolation will not "stay put."

If the effect of the agitation in regard to the New York City census, which is becoming somewhat of a public scandal, should be to introduce the practice of quinquennial instead of decennial censuses, as it well may, it will not have been in vain. The discrepancy is a very serious one. Neglecting inconsiderable fractions, it is in round figures that the New York City police find 1,700,000 people within the city limits of New York in October, whereas the census enumerators only succeeded in finding 1,500,000 persons who were in the city June 1. It is impossible to explain away such a contrast by the difference between the summer and fall population. That explains a large part of the difference, possibly 100,000; but although June 1 is about as poor a date as could be selected on which to begin the census of a great city with a hot summer climate, the summer exodus has then only begun, and it is hardly within the bounds of possibility that it then included more than 100,000 souls. The natural growth of population in four months amounts to



Pipes, Conduits, Etc.

At Intersection of Broadway and Fulton Streets, New York City.

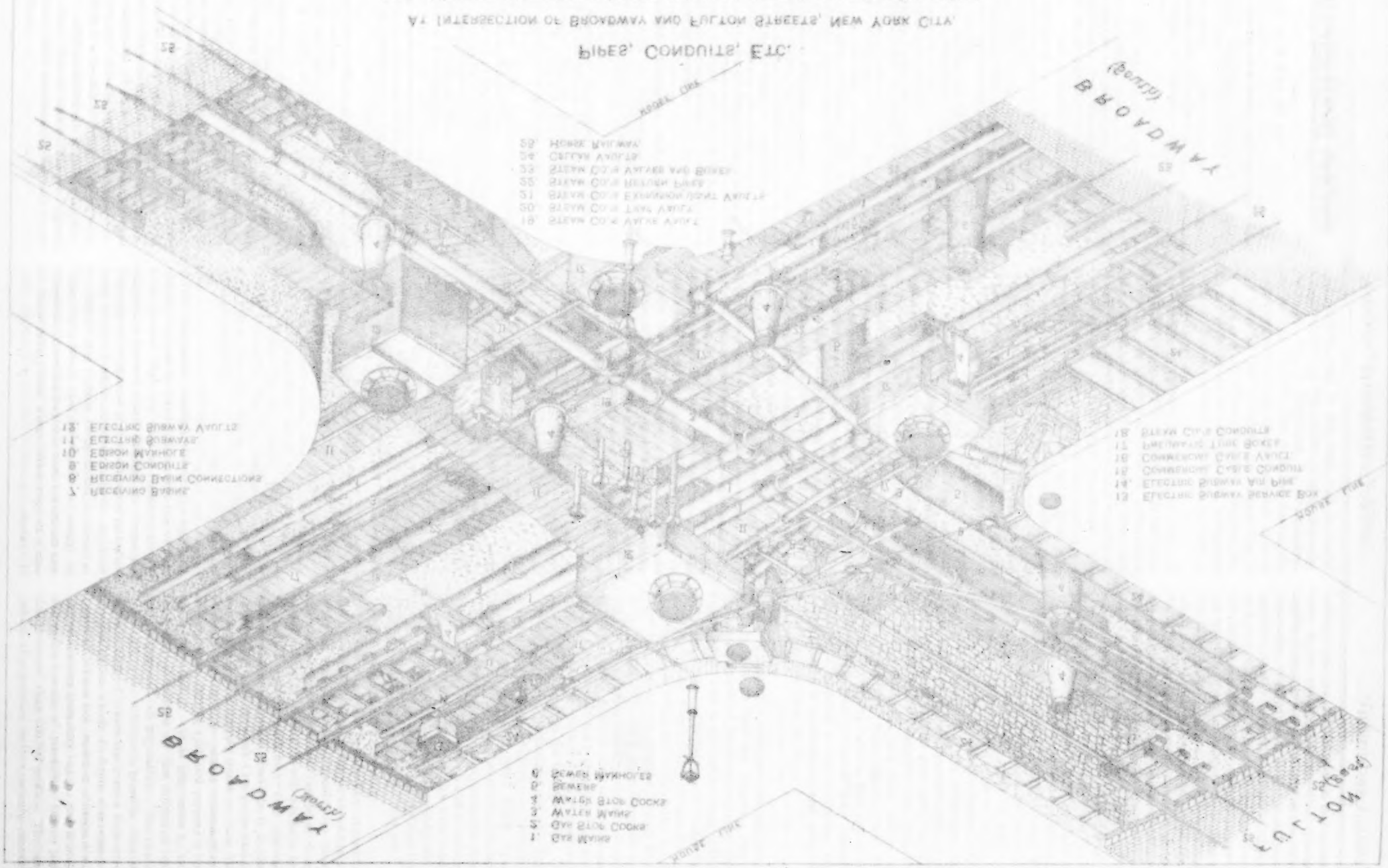
From a Survey and Drawing made by direction of Thomas F. Gilroy, Commissioner of Public Works.

CHAS. HART & BORG. LITH., 33 VESEY ST., N.Y.

From a survey and Drawing made by direction of Thomas E. Dixon, Commissioner of Public Works

At Intersection of Broadway and Fulton Streets, New York City

Pipes, Conduits, Etc.


Broadway
(South)
Fulton
(South)
52
52
52

something, but at 40 per cent. per decade (including immigration) it amounts only to 1¼ per cent., or 16,875 persons. The police may occasionally have repeated names, but it is not likely that any were intentionally added, and this could explain but a trifling fraction of the discrepancy. Moreover, if figures given by the *Evening Post* can be trusted, claiming to represent 163 supervisors' districts out of 175, 12 only being lacking, a total population of 62,138,000 only for the entire country is indicated, which, after deducting the net gain by immigration, amounts to a natural increase of only 13½ to 14½ per cent., the usual rate heretofore having been 22 per cent., from which there is not the slightest visible reason for supposing that there has been any actual decrease. The suspicion is a natural one, that politics may have had too much, and competency too little to do with the appointment of enumerators throughout the country, and perhaps the taking of such appointments out of politics will be another good effect of the present contest. The discrepancy means to New York city the loss of one of its Congressmen, and although some of those whom New York elects could well be spared not only from Congress but from the continent, it is not to be expected that any political party will rest quiet under so serious a loss. It is difficult to see why special enumerators should be appointed any way. It would be far better in many ways to utilize the existing police force of cities under suitable supervision.

The Broadway Underground Tangle.

Many people have heard of the involved intricacy of the network of pipes, tubes, conduits and various underground fixtures buried beneath lower Broadway in this city, but very few realize what this tangle really means. Our inset of this week is prepared from actual surveys made under the direction of the Commissioner of Public Works, and in making this condition of affairs public, Mr. GILROY has presented one of the best arguments possible in favor of an entirely new departure in the disposition of underground street furniture. While the intersection of Broadway and Fulton St. is, from its location, the cause of one of the worst tangles in the city, the condition of affairs there shows what may be expected everywhere, if past practice is to be continued, and what actually exists in a somewhat lesser degree in many other places in this city. In fact, we published in our issue of May 26, 1882, and reproduce in another column, a similar drawing of the tangle of pipes at the corner of Wall and Broad Sts., showing an even worse state of things in proportion to available space.

The problem of relief is an intricate one, only to be solved by the most careful and intelligent engineering study. It must be assumed at the start that any comprehensive and sufficient plan will cost a large sum of money, but the absolute and immediate necessity of doing something in this matter is apparent to any one who will take the trouble to study the text set by Mr. GILROY. The pressure upon the Department of Public Works for more pipes, more conduits, more isolated subways of all sorts, is an ever-increasing one, and the Commissioner is only wise in persistently declining to grant such privileges until some orderly and permanent disposition can be made of those already in use. To continue to simply "bury pipes" is to make the present confusion worse confounded, for some of the systems have been down for years, put there with or without official permission, and usually without record.

Subways of some kind must be used. What type of subway would be best, we cannot say; nor can any one else until the subject has been exhaustively studied in all its confusing and conflicting features. Some four or five years ago a plan was suggested by an English engineer for preserving unbroken the roadway of the Strand, perhaps the most traveled street in the world, and the nearest to Broadway in its demands. This plan proposed to support the roadway, from curb to curb, on a system of longitudinal and cross girders, carried by iron posts or screw-piles and covered with buckle-plates which held up the concrete and street paving. The soil underneath this bridge, for such it was, was to be excavated for some feet, leaving a clear space above an ordinary dirt surface in or on which pipes could be laid and repaired, connections made, and all underground work carried, on without breaking through the surface of the street at any point.

The estimated cost of this was great, but the advantages were correspondingly great. In the first place the best possible type of street paving could be adopted, with the certainty that it had a permanent and solid foundation and could be economically kept at its point of maximum efficiency. Traffic would be unimpeded at any time by street repairs. And last, but not least, the various underground fixtures, that are daily multiplying with the demands of the times, could be systematically disposed of so as to least interfere with each other and to occupy the least useful space. These pipes, conduits, or whatever they were, would be accessible at all times, for repair or extension, without reference to the traffic on the street above. The plan offered the advantage of greater convenience and a marked reduction in expense of maintenance, considerations of the utmost importance, and justly warranting a heavy rental for the use of the conduits.

Each and every one of these arguments applies to Broadway to-day, and the existing confusion loudly appeals for some such prompt and definite action in the direction of relief. It may be argued, with some justice, that the traffic on the Strand is no measure of the actual requirements of Broadway; that while the traffic on the London street is almost wholly confined to omnibuses, hansoms and the lighter vehicles, Broadway is practically the only direct channel of up and down town traffic and that it is subjected to the heaviest loads transported through our streets. This is to a great extent true; though we have seen 10-ton road-rollers at work on the Strand, and once saw an enormous boiler hauled by a very heavy traction engine passing up the Strand on a certain Sunday.

The bridge system of roadway can be made capable of withstanding any possible load; that is only a question of section, foundation and cost. But the masonry type of structure must also be carefully studied, as to its first cost and adaptability. The latter method of construction has some few advantages over the metallic form, other things being equal. Strongly arched subways need not cover the whole width of the street at once, but could be built, at a somewhat increased cost, in parallel series, as funds and the demand might warrant; and brick or stone masonry would last longer, with less of a maintenance account, than iron construction. The isolation in district subways of certain classes of plant, such as steam and electric wires, would be most advantageous; but the same thing could practically be done if iron posts and girders were used, by connecting and enclosing the posts in light walls of non-conducting material.

On the other hand continuous walls of heavy masonry would require deep and expensive foundations, and their construction would mean a long blockade on our busiest street, while work could only be done at certain seasons of the year. Even if a combination of masonry walls and iron girders were to be adopted, the screw-pile foundation would have decided advantages from the builder's point of view, as these could be all put in place before the general street surface was broken for the girder work. In so busy a street as Broadway the inconvenience and direct loss to citizens of any prolonged interference with traffic must be considered.

Just at the present time a survey is being made of underground Broadway by the engineers of the proposed cable railway, and the cross-sections already taken show gas and water mains, up to 36 ins. in diameter in the latter case, and crossing and recrossing the street without any apparent cause in the former case; and electric subways and conduits, pneumatic tubes and steam-heating pipes interlace with each other and twist about sewer man-holes and over cross-town sewers in an utterly lawless and incomprehensible manner.

In some places, further down town, vaults are found extending 10 ft. beyond the curb line into the streets, put there under a permit from the Board of Aldermen granted with little or no regard to the wishes of the engineering departments of the city or as to future use of the whole street by the city. There is abundant evidence that it will take a strong arm and a wise head to cut this Gordian knot and to rearrange its tangled strands in some orderly manner; but all the more honor to the man who does it. A serious attempt at finding a way out of the ever-increasing difficulty cannot be made too soon, and the longer this attempt is deferred the more costly and troublesome will be the final solution.

Schedule Time and Train Service.

An old reader of this journal, a frequent and long-suffering victim of the delays to which the traveler is subject, has had his patience at last exhausted, and sends us the following letter from one of the New York-Chicago limited trains:

> I have just been compelled to send a telegram from this limited train as follows: "Train four hours late. May make up some time, probably will not." Now I am going to use some of the company's fine stationery to make a complaint of the frequent necessity for sending such messages. If you can spare me a little room in your paper, I shall be somewhat relieved from the burden of unexpressed indignation which now troubles me. May be I shall represent many passively enduring Americans. I have been a dozen times between New York and Chicago by "Limited" trains within about a year, and have hardly ever arrived on time. Now I have an important engagement, and am especially exasperated at having to break it.
>
> The published schedule promises the trip in 25 hours, and the trains start very exactly at the minute, but then the promptness usually, or frequently, ends. The performance does not fulfill the promise. Of course there are plenty of excuses and explanations; slippery tracks, washouts and wrecks, but the public does not want excuses and reasons. It wants to keep its engagements. Many comparisons are made by Americans of American with European railways, which show patriotism rather than candor. Our rolling stock may be in some respects better, but they greatly excel us in the regularity of running their trains, and some of their runs are long and fast. A man ought to be tolerably sure of keeping an appointment in New York made the day before from Chicago, especially when he pays extra fare for specially good service, but he cannot now.

There have been, at various times, specific records made of the times at which the several trains arrive at important stations in this country, and we regret extremely that we cannot now refer to one of these without more of a search than is convenient. As to the general fact that it is rather the rule than the exception for long-run trains to be more or less late, there can be no doubt. The same is true of foreign train service, however, and for this better records are available. That admirable body, the Board of Trade, which, in England, exercises an analogous supervision over railways to that exercised here by the Interstate Commerce Commission (less in respect to rates, but much more in respect to operating details), is now collecting returns in response to an order of the House of Commons from all the railways entering London, of the times of arrival of trains in comparison with their schedule times, for alternate months of the year 1890, beginning with January. The returns for July, 1890, lie before us, and we abstract it almost in full in the following table. The only change we have made, beyond omitting two or three lines, is to combine two of the columns with others, so as to show only two columns for trains

between 10 and 30 min. late, whereas in the original return there are four columns.

Arrival at London stations of all passenger trains in month of July, 1890, in relation to schedule time.

Railway.	No. trains averaged.	—Percentage of trains.— On time to 3 m. late.	3 to 5m. late.	5 to 10 m. late.	10 to 20 m. late.	20 to 30 m. late.	Over 30 m. late
Gt. Eastern	9,113	74.3	9.8	9 2	5.1	1.2	0.4
Gt. Northern—							
Suburban	625	69.5	12.3	10.6	6.2	1.1	0.3
Local	2,777	73.5	11.6	10.5	3.7	0.5	0.2
Exp. and through	608	32.3	10.6	24.0	22.3	8.1	2.7
Scotch	219	7.8	1.4	8.2	16.8	17.4	48.4
Gt. Western	2,269	64.9	9.0	13.0	9.8	2.2	1.1
L. & N. W.	1,909	63.2	8.3	12.4	10.1	3.2	2.8
L. & S. W.	6,695	60.4	7.4	19.1	9.4	2.6	1.1
L. B. & S. C.	11,894	63.7	6.5	17.7	9.1	2.0	1.0
L., Ch. & Dover—							
Long dist. (Vict.)	1,167	33.8	12.6	23.9	20.0	6.2	3.5
" " (Hbn.)	1,058	21.7	13.0	24 6	27.6	9.4	3.7
Continental (V.)	182	25.8	5.5	17.0	20.9	6.1	24.7
" (H.)	182	12.6	9.3	15.9	20.9	13.8	27.5
Local (Vict.)	3,331	52.3	14.4	18.5	11.4	2.4	1.0
" (Hbn.)	1,019	68 0	12 0	13.2	5.8	0 8	0.2
Av. all trains	7,867	45.2	13 7	19.9	14.6	3.9	2.7
Midland	1,035	41.2	13.5	21.4	15.9	3.7	4.3
So. Eastern	5,639	58.9	11.9	16.0	9.1	2.3	1.8

In considering this table it is to be remembered that most of the trains entering London have very short runs compared with American practice; and when this table is duly studied it does not seem to bear out our correspondent's claim that the service abroad is in this respect so much better than at home. There are no runs included in the table at all comparable with the New York-Chicago run. The longest is on the famous Scotch mail trains on the routes where the so-called race to Edinburgh took place, and this run is only 400 miles long, or considerably less than from New York to Buffalo, or Pittsburg (444 miles). Only a small percentage of the trains arriving in London have so long a run as from Boston to New York (234 miles), and a large majority a much shorter run than from New York to Philadelphia, 90 miles. It is to be remembered also that the English roads, from the mode of their construction, are in much less danger of casual delays than American roads, having practically no grade crossings either of highways or other railways. They are also (a still more important fact) run almost universally under the block system, and over interlocking switches, so that they have a much better chance than our trains to keep up to any reasonable schedule time.

This being so, it is instructive to study in the above table how very great the influence of length of run seems to be on the punctuality of trains. To make this clearer, we abstract the pith of this table as follows:

Railway.	Percentage of trains arriving. 20 m. or more late.	10 m. or more late.
Great Eastern	1.6	6.7
Great Northern, suburban	1.4	7.6
" local	0.7	4.4
" exp. and through	10.8	33.1
" Scotch	65.8	82.6
Great Western	3.3	13.1
London & Northwestern	6.0	16.1
London & Southwestern	3.7	13.1
" Brighton & South Coast	3.0	12.1
" Chatham & Dover { long distance	9.7	29.7
" Chatham & Dover { long distance	13.1	40.7
" " " { continental	30.8	51.7
" " " { continental	41.3	62.2
" " " local	3.4	14.8
" " " local	1.0	6.8
" " " gen. av'rage	6.6	21.2
Midland	8.0	23.9
Southeastern	4.1	13.2

It will be seen that of the Scotch trains on the Great Northern (which are no longer making the extremely high speeds of the great race) no less than two-thirds arrive 10 minutes or more late, and no less than five-sixths, 20 minutes or more late. Almost an even half of the trains arrive over half an hour late. We hardly think that the Chicago limited has so bad a record as this. Of the so called "express and through long-distance trains," which will average, at a guess, considerably less than the distance from New York to Boston, a third arrive 10 minutes or more late, and a ninth over 20 minutes late.

The same law is curiously illustrated on the London, Chatham & Dover, an important road as respects traffic, but in respect to mileage an insignificant little system in southeastern England, with a main line only 50.4 miles long, and operating only 184 miles in all. The road can hardly have a single train on its schedule with more than a 60-mile run, but it still manages to sub-classify its trains as "long distance," "continental" (trains connecting at Dover with the channel ferry) and "local and metropolitan," indicating how differently the term long distance is interpreted there and here. A vast capital has been expended in giving this line an entirely unobstructed entrance to its two London stations. All its traffic is what would be called here suburban local traffic, except as the "continental" trains may be delayed by non-arrival of the channel steamboats. Yet over a third of its so called "long distance" trains arrive over 10 minutes late, and about an eighth of them over 20 minutes late.

Taking the table as a whole it is not probable that our own railway system makes so bad a showing as this for hauls of no greater length, despite their otherwise less favorable conditions. But it is certain that the showing would be of much the same general nature, and that the through trains, especially, would show a large majority arriving very considerably late. Whenever this becomes the case the public has just cause to complain, and the management just cause to be ashamed of itself. Occasional delays are inevitable, let schedule time be what it may, but as a prominent daily journal has lately argued with much force, there is something dishonest and dishonorable, as well as unfair, in persistently making promises to the public which are more often broken than kept.

To see what the remedy is, however, it is necessary to diagnose the disease correctly. It is quite certainly not due to any large extent to over-fast scheduling of trains, as is often too hastily assumed. On the contrary, it is the slowest trains which are the most apt to be late, as is conspicuously shown in the care of freight trains. These waste half to two-thirds of their "running" time in delays caused by other trains, and it is much the same with the long run accommodation trains. At the usual freight schedule of 15 miles per hour, for example, a train should run over a 100-mile division in 6¾ hours, and from New York to Chicago in 2½ days or so; whereas the consignee is fortunate who receives freight in Chicago within a week of its shipment from New York. The trouble comes chiefly from the difficulty of keeping the trains out of each others' way; only a very small part of it comes from actual inability to make the running time, or from accidents and break-downs.

The immediate remedy, therefore, must lie in reducing to a minimum the interference of trains with each other, and this may be attained in two ways: first, by the general use of block signaling, which will enable trains to safely keep on their course from block to block instead of being held so much at stations; and, secondly, by reducing the difference in the speed of trains, not by cutting down that of passenger trains, which would do little good and is out of the question, but by raising that of freight trains. A very little experimenting or computation will show at once how much more effective in avoiding delays would be an increase of normal freight speed from 15 to 25 or 30 miles per hour than a decrease of passenger speeds by an equal amount.

Now, this latter end is likely to be attained very speedily after automatic train brakes and couplers are in general use on freight trains, for the very good reason that the higher freight speeds will be immensely profitable to the railways, as we recently pointed out in some detail.* When we consider further that the introduction of these betterments will also do away with a considerable proportion of the wrecks and derailments which now cause much delay, it is evident that they will greatly aid in making it possible to maintain reasonable schedule speeds.

But after all, although these betterments will make it easier to do what is now aimed at, the real trouble and the real remedy still lie back of this. The aim itself will become higher, as what is now aimed at becomes easier, and our last state will be much the same as the first. The ultimate remedy lies not in this or that appliance, still less in this or that speed, but in exactitude of administration and thoroughness of discipline. Modern railroading is an attempt to make some thousands of human beings, controling as many different inanimate mechanisms, work together like a machine. Human nature resists such working, and in some respects it is fortunate that it does so, but to the limited extent that it is possible this machine-like regularity must be had if trains of any kind are to be kept on time. How is it to be insured? In our judgment the only possible way for insuring it is by the sunlight of publicity; by just such work as the Board of Trade is doing in England; revealing to all concerned just what is being done, and so introducing the principle of emulation, and making it reasonable and just to demand of all the roads what the best are found to be doing. The real problem being one of human nature, and hence essentially indeterminate, it is quite idle to attempt to figure out on paper just what can or must be done, even with the power of the law behind one, but by simply spreading abroad before the world *the exact facts* as to each road, those who are already doing well are powerfully stimulated to do better yet, while those who are doing ill are exposed to public disgrace if they do not at once do better. It is in such directions as this that public supervision of railways does great good; and we may add that this is one of the few subjects which State Railroad Commissions can still take up with certainty of accomplishing good by separate action.

* "The Money Value of Good Freight Brakes and Couplers," ENG. NEWS, Sept. 21, 1889.

Notes from Abroad.

[EDITORIAL CORRESPONDENCE.]

ENGLISH RAILWAY CARS.

The use of trucks, or "bogies," for rolling stock has increased much more rapidly than for locomotives, and almost every line of importance has now a considerable number of bogie cars. Some of the old short carriages with three or four compartments are still to be seen, but generally on unimportant travel lines; although some few railways still persist in running what are popularly known as "rabbit-hutches" on their main line trains. Even these lines, however, possess better stock of more modern type. The ordinary passenger rolling stock, exclusive of the bogie cars, consists of carriages on two or three rigid axles, and divided into four, five or six compartments; the first-class carriages generally have only four, but composite cars (*i. e.*, cars having compartments of different classes), have different numbers. The bogie cars are of course longer, having sometimes six, seven or eight compartments; or seven passenger compartments and a baggage compartment. These cars are from 34 to 56 ft. long, and I have obtained, through the courtesy of officials, working drawings and photographs which later on will no doubt be presented to the readers of ENGINEERING NEWS. The truck frames are generally of steel plate, and the wheels generally 36 to 42 ins. diameter. The truck wheel base is about 5 ft. 6 ins. to 6 ft. 6 ins. One bogie car, of which I have drawings, is 56 ft. long and 8 ft. wide over the body; it is carried on two six-wheel trucks with 42-in wheels; 5 ft. 9 ins. c. to c of axles, 37 ft. c. to c. of trucks. This car has a guard's and baggage com partment combined, three third-class and three first-class compartments, with two lavatories for each class. The third-class and first-class compartments are 6 ft. and 7 ft. 3 ins. respectively between partitions. Another bogie car is 48 ft. long, 8 ft. wide, 12 ft. 6 ins. high from rail to top of the monitor

roof, which is 16 ins. high; this car is carried on two four-wheel trucks, with 42-in. wheels; 6 ft. 4 ins. c. to c. of axles, 38 ft. c. to c. of trucks. The body is divided into two first-class, two second-class and three third-class compartments, with a baggage compartment and first-class lavatory; it has "coupé" or glazed ends; each compartment has two lamps, one on each side of the monitor roof. Oil lamps are generally used, but on some roads the Pintsch system of compressed gas is used. The light is, as a rule, very dim, much too bad for reading. A very comfortable third-class car in which I traveled about 500 miles one day, had a lavatory and conveniences at each end, a smoking compartment, ladies' compartment and three ordinary compartments. A corridor ran along one side of the car, with a partition and doors. This car was carried on three rigid axles. Compartments average about 6 ft. between partitions, giving 2 ft. clear between seats. The third-class compartments of ordinary cars seat five persons on each side, the first-class three or four persons, each side. Some cars have only one row of seats in the end compartment, the end of the car being glazed. Outside the doors runs a foot-board, not for the guard or conductor to pass along in collecting tickets, but to fill the space between the car floor and station platform; there is another foot-board on a level with the axles, for use by men in switching, etc., and sometimes also useful in cases where the platforms are not as high as the car floor. Long spring buffers are used, two at each end of the car. A center coupling is used, consisting of a chain over hook on the car, drawn tight by a right and left handed screw. Safety chains are also fitted. On some local trains on London lines the cars are made up permanently into trains, and the trains are not broken apart except for repairs; with these trains a link coupling and short stroke buffers are used, bringing the cars very close together. Car wheels are generally of the Mansell type, with retaining rings and wooden block filling; spoke wheels are used to some extent. The journals generally run in grease boxes, but oil boxes are becoming more general now; some of the latter are filled and bolted up for long runs. As to coloring, each road has its own arrangement; sometimes a single color, as crimson (Midland Ry.) or dark plum color (Caledonian Ry.); sometimes two colors, as vandyke brown up to windows, cream for the upper part (Great Western Ry.); some roads prefer the natural wood rubbed and varnished. In all cases the car is picked out in gilt and colored striping and lettering. The upholstering is generally comfortable; the most usual covering is a sort of carpeting, which looks well and keeps its appearance better than plush. On some roads bare board seats are still used in third-class compartments, but in general the compartments of this class are very comfortably cushioned, and have cushioned backs. With six-wheel cars, the four outer wheels usually have squeeze brakes, while four-wheel trucks or "bogies" usually have squeeze brakes on each wheel.

The ordinary "wagons" or freight cars are short, open cars, on two rigid axles with spoke wheels; they have loose chain couplings, bumper blocks or spring buffers, and a hand lever brake with wooden brake and lock, only applicable during switching. Small box cars, on four wheels, are also used. Besides these there are longer cars, on six wheels, used for fish and milk traffic, etc. Carriage trucks (for conveying carts or carriages) and horse boxes (for conveying horses) are generally four-wheel cars, the former having low sides but no ends and the latter being short, high box cars, are among a variety of special rolling stock. Carriage trucks, horse boxes, milk and fish cars, etc., are attached to some of the fast passenger trains, and are therefore fitted with brake hose and gear for the continuous brakes.

Pullman drawing room and sleeping cars are run on four or five lines, but they are smaller than the ordinary Pullman or Wagner cars of American lines. Dining cars are run with the express trains of several roads, and sleeping cars are also used. The London & Northwestern Ry. has some very fine dining cars. Some of the sleeping cars have brass bedsteads, others have berths with reversible bottom, forming a sofa by day and a bed by night. I have only seen one sleeping car with upper berth, and in that case the upper berth rose and fell vertically, being suspended from a "a lazy-tongs" arrangement. All the principal roads have saloon cars for the use of parties, etc.; these have usually tables in the middle, sofa seats round the sides, a lavatory and baggage compartment. Finally I have been in the "royal" cars for the Queen, the Prince of Wales, etc. The Queen has two cars, with a vestibule connection. The day car is upholstered in blue, with gilded cornices, etc., and the royal arms; the lavatory and other fittings are very handsome; the night car has a bedstead and toilet arrangements and is upholstered in red and green. The ceilings are padded and covered with white silk. Oil lamps are used, the Queen not permitting the use of gas, and the cars are fitted with electric bells for the attendants. There is also electric communication throughout the train, and hose is fitted for the Westinghouse and automatic vacuum brakes.

ENGLISH HIGHWAYS.

The excellence of English roads is well-known, and it is a pleasure indeed to one fresh from the wretched roads of America, to find good roads here the rule instead of the exception. The reason of this is that the roads have been properly laid out, properly constructed, and are properly maintained. Formerly the main highways were toll roads, and were maintained by "turnpike trusts," which had their engineers and skilled laborers. The turnpike roads, however were gradually made free, and turnpikes have now I believe, become obsolete; though some of the pretty quaint old cottages and "turnpike houses" still remain but without the gate and turnstile. Under new laws the roads of each county are under the control of the County Council; there is a county surveyor (more properly county engineer, as he has charge of roads, bridges, buildings, etc.), and under him are district surveyors each in charge of a certain district of the county, who have to see that the roads are properly maintained and repaired. The roads are divided into two classes: main roads and district roads. The country roads are generally macadamized, and have a good surface for riding or driving. Limestone is very much used, but is objected to as it very soon wears, and then the road is dusty when dry or muddy when wet. Millstone grit is the next best material. The best stone, however, is granite; and in Gloucestershire granite from Cornwall and Shropshire, is being introduced, with very satisfactory results. It is more expensive than the other stones, but lasts so much longer as to be cheaper in the end as well as better. Hand broken stone is preferred to machine broken, as the latter, often contains a proportion of long straight pieces, and is therefore not so uniform as stone broken by hand. In some cases the stone is broken by machine and then broken smaller by hand, the hand labor being of course much less than in breaking the stone up from the large pieces. Prices of course vary; in Glouces. tershire, I have known 23 cts. per yd. paid for breaking limestone, and 26 to 30 cts. per yd. for granite. In suburban districts steam rollers are very generally used; they roll the broken stone first, then gravel is spread and well rolled down, forming a very good road. In Gloucestershire, it is proposed to use a steam roller on the county roads.

EXHIBITIONS.

England is a great place for exhibitions of various kinds and on various scales, from such as the International Exhibition at Edinburg to those of agricultural associations (which generally include good exhibits of agricultural implements, traction engines and machinery), and those which are mainly for the casual information and amusement of the public, such as the French, Military and Stanley exhibitions now being held in London. The Edinburg exhibition is very interesting, especially in the railway and electrical departments. In the railway hall are 5 large locomotives, 2 modern cars, signals, a Westinghouse brake plant, steel ties, etc. Also collections of photographs of locomotives of various classes (with 6 or 7 large photographs from the Baldwin Locomotive Works, of Philadelphia). The French exhibit includes well-executed colored drawings of the engines and cars of different roads, showing the actual colors; among them the brass sheathed engines of the Orleans Ry. The Mining and Metallurgical Exhibition at the Crystal Palace, near London, is also interesting. It is mainly colonial, and includes trophies of the various ores and minerals, in the rough and finished. The largest exhibit is from New South Wales. In the machinery shed are various rock drills, pulverizers, separators, air compressors, etc., which are well worth looking at, and of which I shall have more to say later on. E. E. R. T.

CORRESPONDENCE.

Is this Andrew Ellicott's Theodolite?

TALLAHASSEE, Fla., Oct. 20, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In the office of the U. S. Surveyor-General of Florida, at Tallahassee, stands an old theodolite or transit, or the wreck of such an instrument, which has been borne on the property list of the office from time immemorial. It is destitute of most of its attachments and the large telescope tube has not contained a lens for years. Different officials have wished to get rid of it, but could not. One petitioned the General Land Office to have it condemned and sold, but as the cost of advertising the sale was more than the old brass would bring, the request was denied.

The frame work is intricate and heavy, of strong wood, iron and brass framed together, about 30 ins. high, supported by 3 hinged legs over 2 ft. long in tripod style. No signs are found to show when or where it was made. Accompanying it is a chain showing marks of long use, which stands on the property list as "one standard chain." This has evidently not been used for the purpose of adjusting surveyor's chains very recently, as it is only about 91 links long. It is composed of 21 links of quarter-inch iron, each about 32 ins. long, with swivels and small rings. It probably weighs 10 to 15 lbs. There is also an ancient sextant nearly complete.

Not believing the theory that this transit, sextant and chain were the ones used by NOAH and his sons to survey the waste lands after the flood, your correspondent set to work to learn something of their early history, with only partial success, as follows:

The office of Surveyor General of Florida was established in 1824, as soon as possible after the territorial government of the Florida purchase could be set in operation. ROBERT BUTLER was appointed to the office. A letter to him, dated Oct. 22, 1824, from GEO. GRAHAM, Commissioner of the General Land Office, speaks of some instruments to be transferred to him by the Surveyor General of Mississippi, GEO. DAVIS, in which said DAVIS describes the defects and injuries of the transit and sextant. Several letters were then exchanged in reference to sending them to Philadelphia for repairs, which does not appear to have been done. The instruments seem to have been shipped from the village of Washington, Miss., to Tallahassee, and to have here remained tied up in official red tape, beyond the power of any one to get rid of them, for the last sixty-six years.

In the musty volumes of official correspondence there may be other allusions to them, but nothing else has been found down to the year 1860, when Mr. J. C. P. KENNEDY, of Washington, D. C., addressed Commissioner JOS. S. WILSON a letter, asking that certain old instruments retained in the Florida office might be delivered to him, because they had been the property of his grandfather, ANDREW ELLICOTT, and used, in 1796, in surveying the national boundary between the United States and the Spanish province of Florida.

Mr. ELLICOTT was one of the best astronomers and surveyors of that age, and had surveyed in the famous "seven ranges" of Ohio. He was one of the two commissioners appointed by President WASHINGTON and the Spanish ruler to survey this Florida land, a task that was finished four or five years later. His mounds are still extant. The north boundary of New York was also marked by a mound established by him, where the forty-fifth parallel intersects the St. Lawrence, as proved by an act of Congress of 1822. He was an intimate friend of WASHINGTON, RITTENHOUSE and FRANKLIN, and has filled important chapters in the history of American boundary lines. Perhaps he used these old instruments when he laid out the city of Washington, just one hundred years ago.

Upon the facts reported to the commissioner about these old instruments, the Surveyor General was ordered by letter of Feb. 11, 1861, to forward them to the General Land Office. But Florida had seceded one month before, and the Surveyor General had written the State authorities offering to place in their hands all the property and records of his office. No notice seems to have been taken of the old heir-looms of the Ellicott family from that day to this, a period of 29 years, except that one Surveyor General in vain asked leave to condemn, advertise and sell them as so much rubbish.

There is much obscurity and uncertainty about the precise history and ownership of these relics, but the accepted tradition and the only written evidence obtainable are as above given. A. W. BARBER.

Compound Locomotive Tests.

LOS ANGELES, Cal., Oct. 19, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In the very interesting report of the tests of the Baldwin compound locomotive, published in your issue of Sept. 13, the consumption of water per HP. at slow speed is given as 20.86 lbs. per hour. Such a result is

scarcely credible. To attain it, using steam of the initial pressure and under the conditions of expansion and exhaust given in the report, the engine must have developed a thermal efficiency of nearly 96%.

The amount of re-evaporation shown by the L. P. cylinder card is also phenomenally great.

Considering the thousand and one obstacles to making accurate observations upon an engine while running the question arises, can even such careful tests as those under discussion be accepted as correct? The extraordinary efficiency shown above would indicate that they cannot.

Would it not be more satisfactory in every sense to make stationary "shop" tests, absorbing the engine power by a hydraulic brake dynamometer or by other means. Such an arrangement would afford every possible facility for accurate measurements and engines and boilers could be tested independently. H.

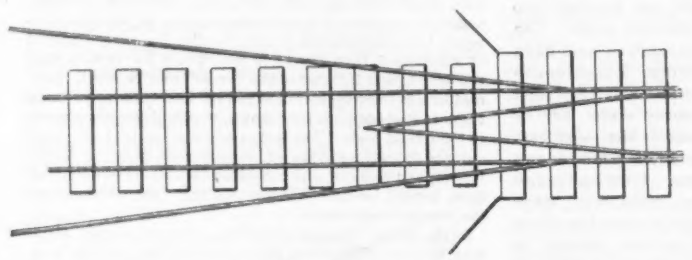
[The performance is certainly phenomenally low, but as 25 lbs. of steam per HP. is not at all uncommon in ordinary locomotive tests made under favorable circumstances for developing a large amount of power economically, and as it is generally admitted that 15 to 20 or more per cent. may be, and is saved, by compounding, we fail to see why 21 lbs. per HP. per hour should be regarded as incredible, and as for its involving 96% of "thermal efficiency" we do not exactly comprehend what our correspondent means, as certainly he cannot mean what he says. It is to be noted that the steam used was probably computed from the diagrams which generally give a much less consumption of steam than actual boiler observations.—ED. ENG. NEWS.]

Safety Guard Rails on Bridges.

WINONA, Minn., Oct. 20, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In regard to the subject of Safety Guard Rails on Bridges, why could not an addition be made to the Latimer guard by placing outside additional guards as shown



on the above sketch, which would cover the case of a car more than half the gauge off the line? It has always seemed to me a practical scheme.

J. H. CURTIS.
Asst. Eng. Union Bridge Co.

It is entirely practicable, and is done in a number of standard guard plans of this type. Usually, however, the outside guard is a heavy stick of timber, and not a rail, in order to get height, and the ties are extended out to carry it, which is almost a necessity.—ED. ENG. NEWS.

Pike's Peak Railway.—Correction.

BROOKLYN, Oct. 27, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: You have made a mistake, on the first page of your last issue, in saying that Pike's Peak is the highest altitude yet reached by a locomotive, except on the Lima & Oroya R. R. The summit level of the Arequipa & Puni R. R., in Peru, is 14,666 ft. above the sea (121 miles beyond Arequipa). I, myself, passed over the road on a train nearly seventeen years ago, soon after its completion to Puni.

Moreover, as the Lima & Oroya R. R. has not yet been completed within some thousand feet of its summit, in altitude, the locomotive has not reached there the altitude mentioned in the paragraph in your paper.

J. F. FLAGG.

[We stand corrected as to the figures. In making our statement we thought only of the location of the Lima & Oroya road, which will, if ever finished, cross the Andes 4,778 m., or 15,672 ft. above the sea level. The Arequipa & Puni Ry. is yet in the lead. —ED. ENG. NEWS.]

Notes and Queries.

A correspondent puts the following query: "The results of tests made at the Watertown Arsenal showing the relative adhesive resistance in wood of wire and cut nails are given in ENGINEERING NEWS of Feb. 18, 1888 (p. 115, Vol. XIX.) Can you give any similar comparison between square and round drift-bolts which will show their relative values in crib work?" [Can any of our readers refer to the case mentioned? We do know, from personal experience, that a round drift-bolt in hemlock timber, driven into a hole bored slightly smaller than the diameter of the bolt, held so firmly that the timber would either split or break before the bolts would draw out. The timber was solid and good, and was used in trestle-work.—ED.]

Track Fastenings in Europe.

The International Railway Convention, held last year in Paris, investigated the different methods of fastening track, on the railways represented, quite exhaustively. The main facts brought forward by the speakers were as follows:

1. Spikes of square or rectangular section are employed by 53 companies, operating 36,900 miles; 9 companies, with a mileage of 15,980, use spikes of a different section or screw spikes. The companies in Northern Europe use a spike 9 ins. long in order to give a firm hold on the tie when the the rails are wedged up to compensate for frost effects. An unusual form, with an octagonal section and a blunt point, was first used on the Paris & Lyons Ry. These spikes, which necessitate boring holes in the ties, are used by 10 companies, operating 6,060 miles. Twenty companies, with 22,630 miles, use screw spikes.

2. Only 7 of the companies represented at the convention do not use base plates; the others find their use very satisfactory. Wrought-iron base plates are liable to break; as many as 8% of the total number on one line have broken in a year. Soft steel, on the contrary, has proved a very satisfactory metal. The convention decided that it was not advisable to use wrought-iron plates, and recommended the use of soft steel with a minimum thickness of .39 to .47 in.

3. As regards boring holes previous to driving the spikes, 18 companies oppose it and 26 favor it unconditionally; 7 recommend holes in hard ties only.

4. Twenty companies use screw spikes (*tirefonds*). The Austro-Hungarian State Ry. advises the use of screws with a long head of square section, as being the easiest form to drive. The Netherlands Ry. claims that the use of these fastenings is dangerous; the hold of the thread on the wood becomes weakened, and as soon as rust appears it is impossible to make the screw perfectly firm. The convention recommends that such screws be given a shaft length of 2.75 to 5.51 ins., a diameter at the head of .75 to .9 in., and a pitch of .28 to .39 in. Ten companies with 16,800 miles of track recommend the use of such screw spikes unconditionally; 6 companies, operating 5,170 miles, only conditionally.

Mr. W. WERCHOWSKI, Russian Minister of Traffic, stated that such screws offer many difficulties in adjusting the track in frosty weather; on the inside of rails, however, they are apparently better than spikes as regards their holding power, while there is little choice between the two methods of fastening on the outside of the rail. The Great Russian Ry. prefers the spike, on the ground that they hold perfectly in the soft wood ties employed on its lines, and can be withdrawn without trouble and without injury to the wood, which is impossible with screws. The Libau & Romny Ry. prefers spikes, as only soft fir ties are used on its lines. The Kaiser Ferdinand Northern Ry. recommends screws on the inside and spikes on the outside of the rail, as does another important Austrian company, the Austro-Hungarian State Ry. The Jura, Bern & Luzern Ry. considers both methods of fastening of equal value with hard wood ties, but prefers screws with soft wood as giving a better hold. With beech ties, two screws or two spikes are used inside the rail; with soft wood, always two screws. On the outside of the rail the present practice is to use only spikes. The Western Ry. of France recommends screws, but adds that they must not be used on the main tracks without bed plates. The convention decided that in cold climates the use of screws cannot be recommended on account of the difficulty of bringing rails fastened with them to grade; that spikes prevent the creeping of rails better than screws; that on the outside of the rail the cheaper spike is as serviceable as the screw.

Notes on Water Supply and Filter-beds.

Mr. W. H. LINDLEY, M. Inst. C. E., in writing on the question of public water supply in the *Deutsche Viertaljahrsschrift fur offentliche Gesundheitspelege*, 1890, classifies the methods of utilizing rainfall for water supply as follows: (1) Subsoil water in the shape of natural springs. (2) Surface water falling in upland regions, collected and impounded. (3) Water from lowlands and valleys

In referring to the fact that water must often be brought great distances to secure purity, as much as 120 miles and more, he says that 100,000 cu. meters of water can be conveyed in cast-iron pipes, at the same price per cu. meter, three times as far as 10,000 cu. meters. Mr. LINDLEY places the cost of conveying water 124¼ miles, at 4 pfennige per cu. meter, the average price of service-water being about 8 to 15 pfennige per cu. meter, or 8½ to 16 cts. per 1,000 gallons.

In discussing covered versus open reservoirs and filter beds, Mr. LINDLEY says that the ordinary English open reservoirs and filter beds cost, with all inlet and outlet pipes and apparatus complete, $8 to $10 per superficial yard. A recent careful estimate for a set of covered filters, with an area of 48,000 sq. meters (57,600 sq. yds.) figured out at $13.44 per sq. yard. Uncovered filter beds cost, approximately, two thirds as much as covered ones. The cost of the latter is set down at about 12 cts. per cu. ft. of effective capacity.

The cost of settling water in covered reservoirs, inclusive of interest and sinking fund on outlay, is from $2.18 to $2.72 per million gallons. Filtration in covered beds will cost from $8.16 to $13.60 per million gallons. Of these sums from 50 to 60% represents interest and sinking fund, and from 40 to 50% wages and material. The bacteriological result of efficient filtration implies reduction of the germs capable of cultivation in 1 cu. centimeter to as low as from 50 to 150; the number in the mains being 300 at the outside.

The original paper of Mr. LINDLEY is apparently very full of general and valuable information on this subject. But the above is condensed from the "Abstracts of Papers" of the Institution of Civil Engineers, the original not being available at present.

The Comparative Cost of Aluminum.

An article in *Le Genie Civil* of Sept. 13 on the properties of aluminum as compared with other metals gives the following interesting table. In this table the last three columns compare the actual value with equal volume, taking for the unit the volume of one kilogramme of aluminum (379 cu. centimetres), and taking the French prices of the metals on Dec. 1, 1889:

Metals.	Price per Kilo.	Price per lb.	Density.	Density compared with Alu.	Price of 379 cu. centimetres.*	Relation with Alum.
Gold	3,400f.	$309.05	19.3	7.31	21,853f.	1,242
Platinum	1,360	123.63	21.5	8.15	11,085	551
Silver	168.60	15.33	10.5	3.98	671	33
Nickel	6 00	.54½	8.9	3.30	20 21	1.01
Manganese	6.25	.57	7.2	2.73	17.06	0.85
Tin	2.60	.236	7.29	2.76	7.81	0.39
Copper	1.40	.127	8.90	3.37	4 72	0.23
Zinc	0.63	.057	7.14	2.70	1.72	0.086
Lead	0.40	.037	11.35	4.30	1.71	0.085
Cast Steel	0.35	.032	7.7	2.91	1.02	0.05
Iron	0.225	.020	7.7	2.91	0.67	0.03
Aluminum	20.00	1.82	2.64	1.00	20.00	1.00

* The volume of 1 kilogramme of aluminum.

The figures for comparative densities do not agree exactly with those given in ENGINEERING NEWS for Feb. 22, 1890, but the discrepancy is due to the fact that the specific gravity of commercial aluminum varies considerably.

One of the features of the great volume of aluminum as compared with its weight is that for plating purposes sheets of aluminum can be substituted for those of silver, as is done at Nuremberg and Furth, in South Germany. In that country, however, the metal is obtained chiefly by electrolysis and has a quite variable constitution as shown by the following table:

Grade.	Price per lb., $.	Silicon, per cent.	Iron, per cent.	Aluminum, per cent.
0	2.84	0.06	0 04	99.9
1	2.27	0.18	0.21	99.61
		0.51	0 34	99.33
2	1.82	1.84	1.37	96.79
		3.82	3.34	92.84

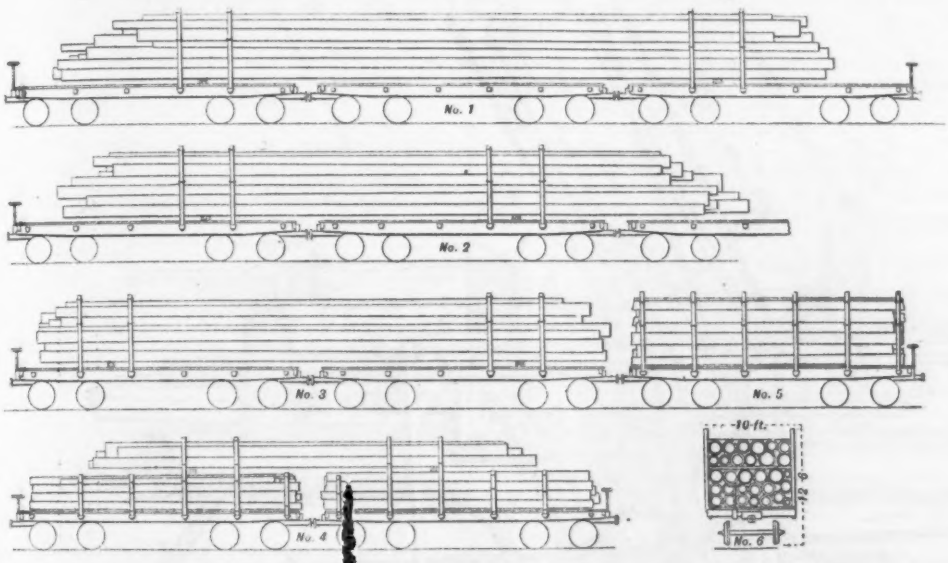
The recent cut to $1 per pound in the price of aluminum made by the Cowles Co. as already noted in this paper, reduces the price of the metal per unit volume, not unit weight, to less than that of nickel and but little more than that of tin. A very full description of aluminum and its properties, both chemical and physical, will be found in ENGINEERING NEWS of Feb. 22 and March 1, 1890.

Loading Logs on Cars.

In response to the request of a correspondent, we give herewith the drawing accompanying the report of the Committee on Loading Bark and Logs on Cars, the substance of which we have already published, and which seemed so clear as hardly to need illustrations. The method of loading illustrated has now become an M. C. B. standard by the vote recorded two weeks ago.

The diagrams are so clear as hardly to need explanation. No. 1 is for logs longer than two car lengths. When there is more timber of this length than can be carried in one load five cars may be used for two lengths of timber, if long enough, each load being carried on two cars "with bearing pieces of sufficient thickness to keep the timber clear of the car floor throughout, at a point between the trucks of each car, and near to those next to the end of the load," all as shown in No. 2.

No. 3 shows the simpler case for 2-car length timber. If the timbers are too short for the position shown the saddles may be brought closer together, "to any point between the trucks sufficiently near to each other to prevent the shortest from working out between the stakes, two stakes being fixed on both



M. C. B. STANDARD METHOD OF LOADING LOGS AND POLES ON CARS.

sides of each car in pockets nearest to saddle or bearing piece, and tied across with telegraph wire to keep the load from spreading, one wire being over the top of the load, one about one-third down, so as to prevent the stakes working or spreading out. The stakes should be made of exceptionally good material."

When a few poles have to be loaded on the top of two cars of short ones, a bearing-piece may be securely fixed across each car on the top of the short poles, to keep the long ones clear, as shown in No. 4. Only two of the stakes on each side of such cars must run up so as to allow them to curve freely. The section, No. 6, shows the limit of height and width established.

When the load occupies more than one car the weight must not exceed two-thirds of the nominal capacity.

The rack for loading back is a simple affair, composed of four 4 × 4 sticks in the side pockets, connected across by 2 × 4 cross sticks. No precise dimensions are specified.

The Effect of Spiral or Transition Curves to Reduce Shock on Very Sharp Street Railway Curves.*

In ordinary railroad practice spiral curves are, in theory, no new thing, although even in this field they have never received the attention which the importance of the subject demands. I feel safe in making the assertion that there is no road in the country where they have been introduced that would now think of building a railway involving what might be considered even moderately sharp curvature without the use of spirals.

In the construction of street railways we are obliged to use curves very much sharper than the engineer of an ordinary railway is ever called upon to contend with. At the same time our rolling stock is comparatively little better adapted for traversing sharp curves. So long as street cars were operated by animal power only the speed was necessarily slow and the need of transition curves but little felt. With the introduction of mechanical motors the weight of our rolling stock is immensely increased, and at the same time the maximum speed is probably three times greater than with the old system of horse power. The practice of running cars in trains immensely increases the difficulty, so that now the blow given by the leading outer wheel as it first strikes the outer rail at the entrance of the curve is probably ten times greater than with the horse car.

So long as circular curves only are used, there is but one way of reducing the shock to passengers and the constant danger of derailment at these points, and that is to reduce the speed of the train. In the crowded business streets of a great city this reduction of speed is perhaps no disadvantage.

There are, however, many places in the suburbs and outlying districts where a reduction of speed would not be necessary but for the presence of the curve. It is in such places as these that the spiral will have the greatest advantage, although even at slow speed the passage of a sharp curve properly "spiralized" will be found infinitely smoother and better in every way.

In the practical application of the spiral to street car curves, I have not as yet been able to give it as thorough a test as I could wish. However, I have done something in this direction. During last March, while in the employ of the Denver & Berkeley Park Rapid Transit Co., at Denver, Colo., I laid out a curve of 140 ft. radius, using spirals 100 ft. long. The line was built to a 3 ft. 6 in. gauge and operated with Baldwin steam motors, weighing about 32 000 lbs., with trains of from one to three 8-wheel cars, each 30 ft. long. This was my first experience with a sharp curve spiralized. The first train to pass this curve was sent round at a speed of 10 miles per hour. No jar whatever was felt upon entering the curve. Afterwards it was tried at higher speed, until finally, as a test, an engine was sent round this curve at 25 miles per hour and still there was no sign of shock or jar when entering or leaving the curve. This line had previously been in operation something over a year, and a great many passengers were in the habit of locating the point where they wished to leave the train when coming home at night by passing this curve.

After the spiral curve was put in, dozens were carried by their stopping place on account of the trains passing the curve so smoothly that sitting in their seats they did not notice it. Afterward I made another test with a curve of 70 ft. radius, with results proportionately good. As yet I have had no opportunity of testing the advantages of the spiral on curves of 40 and 50 ft. radius, but I firmly believe that by using spiral transition curves we may double the speed in passing any given curve without increasing the danger of derailment, and with much less strain or shock to cars and motors.

In regard to the methods of laying out these curves, I use a method in some respects different from any one else, so far as I know, but the methods of WELLINGTON, SEARLE, or HENCK may be used. Either will give satisfactory results. Perhaps the best method as yet published may be found in a pamphlet, "The Railroad Spiral," by Prof. D. M. GREENE, of the Rensselaer Polytechnic Institute, of Troy, N. Y.

It will matter but little what method is used. But care should be taken to lay out the spirals accurately; and in laying track, rails should be curved very carefully. If points are set on the spiral from 5 to 10 ft. apart the trackman can stretch a line of one rail length along spiral and take ordinates for curving rails directly from the stakes.

*A paper by Mr. E. L. WOOLLEY, Superintendent Lincoln Street Ry. Co., of Lincoln, Neb., read before the American Street Ry. Association.

Frame for Cleaning Sewers.

The device shown in the accompanying cuts, taken from the *Wochenschrift* of the Austrian Engineers and Architects' Club, was designed by Herr EMIL SOKAL for removing the sediment in the Warsaw sewers.

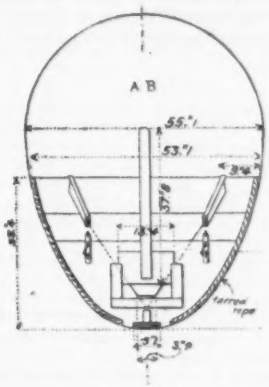


FIG. 1.

From Fig. 1 it will be seen that the frame consists of a wooden partition nearly filling the lower part of the sewer section and resting on a plank 1½ ins. thick, pointed at the end. This plank rests on the bottom of the sewer, and is pushed along by the pressure of the water against the shield, tearing away the deposits in its progress. The bracing is shown in Figs. 2 and 3; the shield folds up as shown by the dotted lines in Fig. 2 for ease in inserting into the sewers. The small sliding door enables the workman managing the frame to maintain a sufficient depth of water over the sediment to keep the mass in a soft condition and wash away the loosened portions.

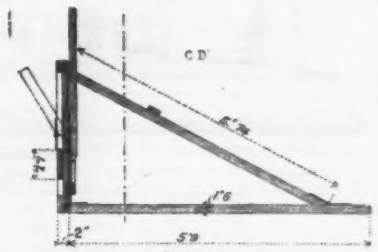


FIG. 2.

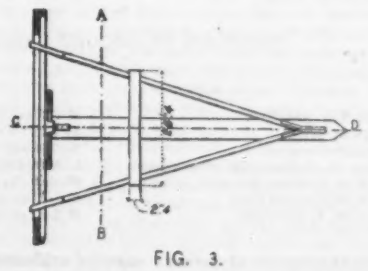


FIG. 3.

The way in which the cleaning process is managed is as follows: The flushing gates are closed at one end of the sewer to be cleaned and the frame is inserted in place. The proper amount of water is then turned on and the workman in front of the shield regulates its motion by opening or closing the small slide.

This apparatus has proved very satisfactory in practice and materially reduced the expense of cleaning the sewers. A somewhat similar device, on a much smaller scale, has been used in Boston, Mass., for small circular sections.

The Need of Subways.

(WITH INSET.)

We present in the inset sheet which appears in this issue a drawing showing the tangle of pipes which exists at the corner of Broadway and Fulton Street, and in the accompanying drawing, reproduced from our issue of Aug. 2, 1882, is shown the state of things which *did* exist eight years ago at the corner of Wall, Nassau and Broad Streets, and which has since, of course, become much worse. Comment is needless, from one point of view, but in regard to what can best be done to relieve this state of things we have had a few words to say in another column.

London Street Paving Practice.

Some interesting detail is given to the Detroit *Free Press* by Alderman WALTER H. COOTS, of that city, regarding paving practice in London. The following is the result of several months' evidently close observation:

Every street in the city is well paved, either with wood, asphalt, granite or macadam. A large percentage is macadam. The foundation for all paving except macadam is concrete.

In preparing the foundation the engineer drives stakes across the street, showing the true crown. On top of the stakes they nail slats one-quarter of an inch thick. The concrete is then shoveled in until flush with the stakes. A 3-ft straight edge is then used on the slat, which is then raised up or hammered down until the slat forms the true grade or crown of the street. This is done every 16 ft. The spaces between are filled with concrete until about flush with the slats, and tamped with shovels as fast as filled in. Then fine sand and cement is placed on top. It is then struck to the true grade and crown by drawing a 17-ft. straight-edge over, keeping the ends of the straight-edge on the slats. The concrete thus completed is almost as smooth as a hard plastered wall. After the concrete is thoroughly set, the slats are removed, and the space plastered over with cement.

The blocks used for wood paving are Norway pine, free from sap or rotten knots, sawed with fine saws, 9 ins. long, 6 ins. wide and 3 ins. thick. A block that is one-eighth of an inch more or less is rejected. The two courses next to the curb are laid parallel to the curb and from 1½ ins. to 2½ ins. from the line of the curb. The space between the curb and the blocks is filled with fine sand without being tamped, which they claim serves the purpose of a cushion and allows for the expansion of the blocks. If this was not done, they claim the heat and rain would cause the paving to bulge up in the center.

In paving a street the blocks are laid across the street ¼ in. apart, with a slat ¼ in. wide between. The latter is removed when the course is completed. The city inspector watches every course that is laid and removes every defective block that comes under his eye, replacing it himself with a sound block. As they progress they wheel on in wheelbarrows cement and sand, properly mixed. The pavement is then watered, the cement and sand sprinkled and, with whalebone brooms, swept over until the interstices are completely filled. Two men with iron implements are kept busy keeping the blocks at proper distances apart and in true courses. If, after slushing, the courses are not true they are taken up and relaid. When the work is satisfactory to the proper officer of the Board of Works, ⅛ in. of very fine shingle is spread over the surface, and the pavement is ready for traffic.

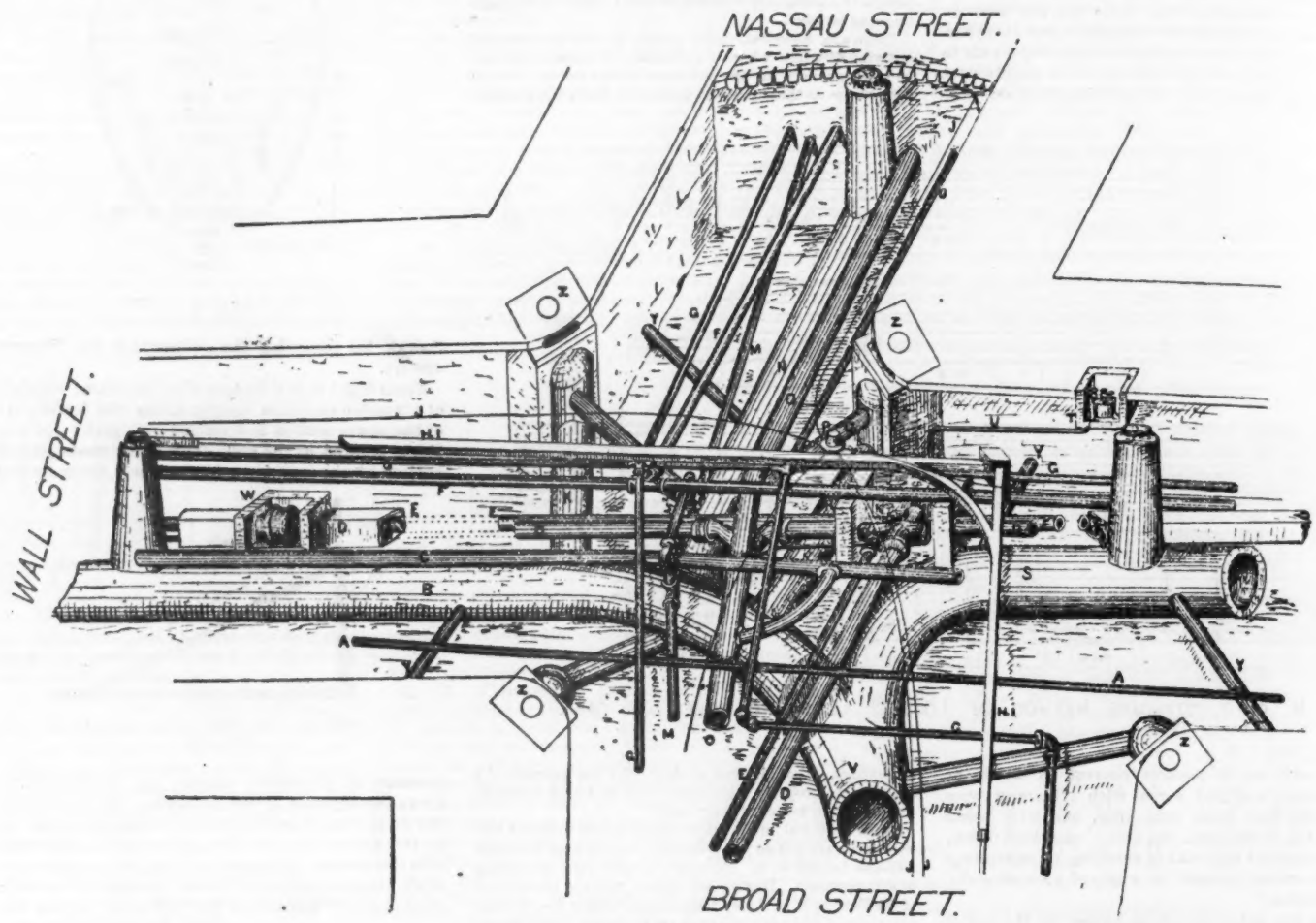
For granite block pavement, on top of the concrete is placed from 1½ to 2 ins. of very fine shingle. Blocks from 8 to 10 ins. long, 8 ins. wide and 3 ins. thick, are laid in true courses across the street, breaking joints from 2½ to 3 ins. Their method of laying granite blocks is different from ours, and gives better results. Three courses of blocks are laid every 16 ft. on the street to be paved, then the spaces between are brought to a true crown and graded by means of a 17-ft. level. Then, as in wood paving, fine screened gravel and cement is "slushed" over, filling all joints and spaces. A top dressing of fine shingle is then sprinkled over the pavement and it is ready for use.

I watched the repaving of Regent street with yellow pine from the Baltic. The old paving had been down 8 years, and had worn down in the center to a thickness of 3 ins., and was still what we would consider a good pavement, being smooth and free from holes. There was no perceptible rot in the old blocks. The specimen which I brought home with me is about an average. The contract price for paving is seven shillings, or $1.75 a sq yd., the contractor removing old paving and repairing foundation when necessary.

I saw them repave King William St. with asphalt. The old paving was the same, and had been down 12 years, and was then in a good and fair condition, but had worn thin. The asphalt used in London is what is known as the Val de Travers rock asphalt, and is brought from the mines of that name at Neufchatel, Switzerland. No other kind is used to any extent. Trinidad is not laid in London at all.

London sidewalks are all in first-class condition, and are the same as the streets repaired by the city, when needed. Such a thing as notifying or waiting for a property owner to repair the sidewalk in front of his property is unknown in London. When a street is paved new sidewalks are laid on both sides, and the expense is included in the paving assessment.

The tramways in London are constructed on a plan that is a great improvement over the way street railways are built in this city. In London they use a rail 8 ins. wide, with a flange at the bottom 6 ins. across. At the top it is 3 ins. across, allowing 1½ ins. for the wheels to run on, a 1-in. groove for the flange of the wheel, and ¼ in. for an inside space. The top of the rail is perfectly level



CONDITION OF GROUND UNDER ROADWAY AT INTERSECTION OF WALL, NASSAU, AND BROAD STREETS, AUGUST, 1882.

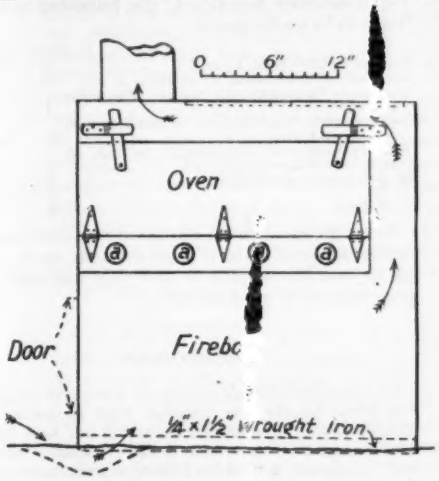
Reproduced from our issue of August 26, 1882.

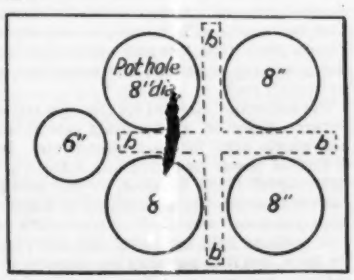
A. 6-in. N. Y. gas pipe.
B. Wall St. sewer.
C. 12-in. water pipe.
D. 15-in. N. Y. Steam Co. pipe (steam).
E. 4-in. N. Y. Steam Co. pipe (return).
F. 8-in. Mutual gas pipe.
G. 4-in. N. Y. gas pipe.
H I. West. Un. pneum. and cable tubes.
J. Edison electric tube.
K. Old basin outlet (removed).
L. New basin outlet, 15-in. pipe.
M. 6-in. water pipe.
M I. Line (before alteration).
M 2. Line (as altered).
N. Nassau St. sewer.
O. 20-in. water pipe.
P. Edison electric junction box.
Q. New basin outlet, 15-in. pipe.
R. Old basin outlet (removed).
S. Wall St. sewer.
T. N. Y. Steam Co. steam trap.
U. 2-in. trap pipes.
V. Broad St. sewer.
W. Expansion joint and service box N. Y. Steam Co.
X. Junction vault of N. Y. Steam Co. mains.
Y. House drains.
Z. Catch basins.

across, so that when laid the inside and outside edges of the rail are true to the crown of the street, thereby avoiding the cramping and sliding of wagons and other vehicles in crossing the tracks. They use no stringers, sleepers or spikes. The rail is laid on the concrete, the ends well bolted together by plates inside and out. The pavement is laid up to and between the rails, keeping them in place.

A Camp Stove.

There is no more important detail of camp equipment for an engineer corps in the field than the cook stove, unless indeed it be the cook who manipulates it. A camp can be fed, and well fed, with no other cook-stove than a camp fire and the utensils which are readily used with it, as we can testify





from experience; but as a rule only a culinary genius can do this and a light and good cook stove greatly conduces to the comfort, and hence to the efficiency of the party. From the last issue of the *Proceedings of the Arkansas Society of Engineers and Surveyors* we extract the accompanying sketch of a cook stove which is said to have rendered good service, contributed to it by Mr. E. C. BUCHANAN, and thus described:

"In 1886 Mr. H. G. MARTIN and the writer were engaged in a resurvey of the land grant of the Little Rock & Ft. Smith R'y., and were often forced to ride six to eight miles from our work in order to find lodging for the night. We finally decided that a cheap camp outfit would be economy to the railway company and much more comfortable to us. There was little trouble to decide what was needed until we began considering the cooking outfit. The usual pattern of cast-iron cooking stoves weighing 200 lbs. or more was too cumbersome and expensive for our purpose, and, after much planning and waste of paper, the design shown was adopted, which the writer thinks is well adapted to the needs of surveying parties much larger than ours. It should be made of No. 14 to 16 charcoal sheet iron, weighs 60 to 80 lbs., and costs $7 to $12. For the sides, No. 6 to 8 iron is used, with four "pot holes" each. It is not patented. The pipe, five joints or less, can be packed in the fire-box for transportation.

"The arrows show the direction of the draft; *d* is a +-shaped brace between the pot holes ¼ in. × 2 ins. (see top view); *a a a a* are ventilators closed by a button or slide. The bottom is hemmed all around with ¼ × 1½-in. wrought iron; the fire-box has no bottom; the fire being built on the ground under the oven. The draft hole is simply a hole in the ground under the door, the draft being regulated by raking a more or less liberal supply of dust into the hole."

The American Institute of Architects.

This association of American architects, which holds its annual meeting in Washington, this week has rather a peculiar corporate history. It was first organized Dec. 7, 1836, in the Pennsylvania Academy of Fine Arts, in Philadelphia, but after a brief existance it died out, owing chiefly to the small number of properly trained architects in the country.

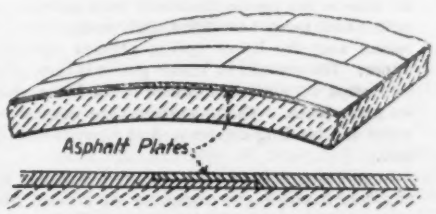
In 1846, however, another organization was started in New York with the same name, but was not incorporated until 1857. Excepting for the period covered by the Civil War, the new society continued to grow until in 1887 chapters were in operation in twelve of the chief cities of the United States. In 1889 the Western Association of Architects, which had been formed in 1884 on similar lines, united with the Institute and made the organization still stronger.

One of the peculiar features of this association is that in the first 30 years of its corporate existence it had but two Presidents, the late Mr. RICHARD UPJOHN, from 1857 to 1876, and Mr. THOMAS U. WALTER for 11 years, until his death in 1887. There were also but three treasurers in 32 years—viz., the late Mr. J. C. WELLS, 3 years; the late Mr. R. G. HATFIELD for 19 years, and his brother, Mr. O. P. HATFIELD for 10 years. The demands upon the Secretary were more excessive, and 13 architects filled the position consecutively in the interval of time above given. Among these were many of the most prominent architects of this country, commencing with Mr. R. M. HUNT, who filled the office for 4 years. The present officers are: Mr. R. M. HUNT, President; Mr. I. W. ROOT, of "The Rookery," Chicago, Secretary, and Mr. SAMUEL A. TREAT, Treasurer. Annual conventions have been held in various cities of the United States since 1867.

Asphalt Plates for Waterproof Construction.

There is a form of asphalt widely employed abroad for keeping out water from cellars, arches, tunnels and similar structures which does not seem to be known on this side of the Atlantic. We refer to the asphalt plates or boards illustrated in the accompanying cuts. It is well known that if the back of an arch has been covered with cement or a layer of common asphalt, that cracks in the mass will appear as settling takes place, and water will enter into these crevices, which are in the weakest parts of the structure. To remedy this cracking, the asphalt was formed into boards or planks about 9 ft. 10 ins. long and 32 ins. wide, made by alternating layers of the asphalt with long, tough vegetable fibres. In this way, flexible and somewhat elastic plates are formed which make an impervious, yet yielding, surface when laid as shown in the cut.

These plates have been used since 1855 in Germany, and their immense sale there shows that they satisfy the conditions in that country. They are often used to keep the inside of an arch dry, over 119,600 sq.



yds. having been laid in this way over the arches on the Berlin City Ry. The spaces thus kept dry are let to shopkeepers for stores. Many of our readers have doubtless seen the Friedrichstrasse station on this line where there are a large number of such shops. A case is on record where a crack of about 2 ins. occurred in the masonry on which these plates were laid, yet such was their tenacity that they held together and preserved the surface in its watertight condition until removed for repairing the arch.

They are often used in repairing old viaducts and similar structures. Thus the Eagle's Bridge near Wildenschwerdt was provided with these plates in the manner indicated. The backing was excavated to a proper depth, drains put in and a course of brick laid on the sand and gravel remaining. On this course the asphalt planks were placed. In like manner various other bridges have been protected.

A frequent mode of application is shown in the section of the tunnel under the railway at Carlsruhe, where the entire structure is protected from water.

The manufacturers are Buesscher and Hoffman, of Eberswalde.

The Electric Lighting of Railway Trains.*

The authors give a résumé of the report presented to the International Railway Congress, on the subject of electric lighting of trains in 1889, dividing the subject into two heads, the technical question of how it may be and has been carried out, and the commercial question, at what expense, in comparison with gas and oil. The technical question involves a description of the various methods that have been tried under the following heads:

1. Primary batteries; 2. Secondary batteries, or accumulators; 3. Accumulators charged by a dynamo driven by one of the carriage axles; 4. Accumulator charged by a dynamo driven by a steam engine on the locomotive. 5. The electric lighting of trains passing through tunnels, by means of fixed generating plant, the train making contact with a rail laid in the tunnel.

Taking these in order, the first system has been tried in England, America and on the continent; but may be said to be now definitely abandoned.

Lighting by means of accumulators is now adopted in almost every instance in one or other of the methods above, viz., 2, 3 or 4.

Prolonged experiments on the Pennsylvania R. R., and also on the Boston & Albany R. R., have shown that under working conditions an efficiency of 60%, and an output of 4.5 ampere hours per pound of electrode, or 3 ampere hours per pound weight total may be obtained from cells of the E. P. S. form (lead grids pasted with lead oxides).

Experience has also shown that it is preferable to use low volt lamps—not exceeding 30 volts, and to use a lamp of 6 or 8 candle nominal, with reflectors.

Experience on the railways quoted above showed that an annual depreciation of 5 to 10% for the negative plates, and of 30% for the positive plates, would represent a fair average. The average allowance now made in America for a depreciation fund is 25% on the original total cost of the cells. The lamps last from 800 to 1,200 hours; but more generally about the former, the vibration being the chief cause of breakage of the filaments. On the State railways in Belgium the system tried is the same as that used in England on the London, Brighton & South Coast Ry., consisting in the use of a dynamo driven from the axle of the guard's van, in which also is placed the battery of accumulators, the connection from the dynamo to the accumulators being broken when the speed of the train falls below a certain limit; and an extension of this principle was adopted by the Southern Ry. in Austria, where a centrifugal governor varied the number of accumulators, in correspondence with the velocity of the train, so as to produce a constant electromotive force at the terminals of the dynamo feeding the lamps. In another system, tried by the management of the Frankfort-on-Main line, the accumulators were in series with the lamps (the latter, however, being in parallel with one another) as long as the train was running, the cells being in two parallels. When the train stops, and the accumulator alone feeds the lamps, the two parallels are coupled in series, and disconnected from the dynamo. The system is very complicated in its details.

In some trials on the State Ry. of Wurtemburg, a different arrangement was made. Each carriage had its own accumulators, and these, with the lamps, were fed from one pair of mains, connected to a dynamo in the guard's van. An automatic switch inserted or removed a resistance from the lamp circuit of each carriage, according as the cells were charging or discharging. The dynamo itself was controlled by an automatic regulator, and the dynamo cut off when the speed became less than about 18½ miles per hour.

Even with all these arrangements there were sensible variations in the light when they acted; so two sets of cells were arranged in each car, one of which was charged while the other supplied the lamps; while in a further extension of the same plan, all the cells being charged were connected to the dynamo mains, and all the cells feeding the lamps were connected to the lamp mains, which also went right through the train. The system used on the Midland Ry. is the same as the first tried at Wurtemburg, with the addition of a third wire carried along the train, and allowing the guard to extinguish the lights when unnecessary.

The use of a separate engine driving a dynamo on the locomotive has been tried in America, and also in England on the Great Eastern and Great Western railways. No details are given as to results.

The only two cases at present of lighting trains in tunnels from a central rail fed by a fixed dynamo are the Glasgow City Ry., and the tunnels on the line between

* Abstract in Trans. Inst. C. E. of a paper by E. SARTIAUX and L. WEISSENBRUCK in "Annales Telegraphiques," Vol. XVII., 1890, pp. 58 *et seq.*

Kieff and Odessa, while on the Fitchburg Ry. (U. S.), the whole tunnel is itself lighted by 16 c. p. lamps.

The authors give tables showing the cost of the various systems, which may be summarized thus:

Systems adopted.	Cost of plant per lamp of 5 c. p.	Working cost per lamp of 5 c. p. per hour.
1. Primary batteries.....	No data.	24 cts.
2. Accumulator alone (charging dynamo not included)	$41 to $31	1 to 0.4 cts.
3. Accumulator and dynamo driven from axle.	$77	0.9 cts.
4. Accumulator and dynamo driven by separate engine.....	$70	1 to 0.6 cts.

The only information given as to the cost of lighting trains in tunnels by means of a central rail is, that in Russia the cost is one-third of that of gas.

The comparative cost of lighting by gas and oil is given as follows: Gas from 0.72 cts. to 0.96 cts., and by oil, 1.08 cts. As to dead weight carried, the accumulators necessary for a saloon-carriage requiring 21 lamps, weigh 1,200 lbs., and the apparatus for Pintsch gas illumination for the same carriage would weigh from 900 lbs. to 1,320 lbs.

"Wootz."

The *Times of India* writes: "It would certainly be worth while to take the question of producing 'wootz' on a large scale into consideration. If it paid a Persian trader to make periodical visits from Ispahan to Nirmal in the Subah Berar for the sole purpose of obtaining this iron for the Persian armorers, it would probably pay to export it to England. The iron is found in a very pure state in fine grains among a kind of mica schist. The treatment of the ore was local and peculiar; two qualities of iron obtained from magnetic iron sand and laterite respectively, were blended in the steel crucibles. Very hard steel cakes, called by the natives 'wootz,' were thus produced, the heat to which they were subjected being exceptionally high."

The First Steamboat.

As it is fashionable just now to overthrow pet and long-held theories regarding more or less mythical heroes and original inventors, the Cincinnati *Times-Star* of Oct. 10 gives the following, in substance, as evidence that EDWARD WEST, of Lexington, Ky., and not ROBERT FULTON, first applied steam to water navigation:

A long-forgotten notice in the *Western Spy and Hamilton Gazette*, of Cincinnati, O., reads as follows:

LEXINGTON, Aug. 11, 1831.—On Thursday Mr. Edward West exhibited to the citizens of this place a specimen of a boat worked by steam applied to oars. The application is simple, and, from the opinion of good judges, will be a great benefit in navigating the Ohio and Mississippi rivers. Mr. West intends to apply for a patent for this discovery.

Mr. GEORGE W. RAUCK, in his history of Lexington, refers to this event, but dates the invention back to 1793, without being able to give exact proof, however. He quotes in support of his theory the following from the *Kentucky Gazette* of April 29, 1816:

Steamboats—A steamboat owned by a company of gentlemen of this town (Lexington) was to sail to New Orleans yesterday from near the mouth of Hickman Creek. We are informed that she is worked on a plan invented by Mr. West, of this place, nearly twenty years ago, and in a manner distinct from any other steamboat now in use. On trial against the currents of Kentucky, when that river was very high, she more than answered the sanguine expectations of her owners, and left no doubt on their minds that she could stem the current of the Mississippi with rapidity and ease.

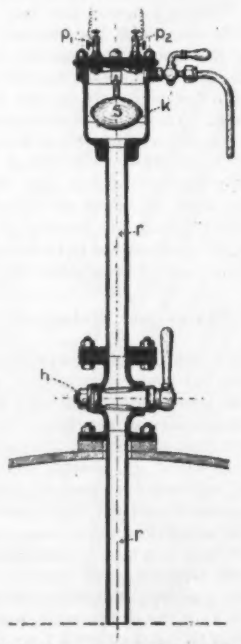
Whether Mr. WEST really obtained his patent in 1801 or not, the *Times-Star* concludes that the first notice indicates that he had fairly perfected his invention at that time; whereas it was not until 1803 that FULTON made a working model of his boat, and not until 1807 that he built a boat, the *Clermont*, that would travel at the rate of five miles an hour.

The weak point in the above conclusion of our Cincinnati contemporary is that JOHN FITCH, OLIVER EVANS, RUMSEY, SYMINGTON, of England, and others had practically operated steam boats years before the date of the first paragraph, or 1801. SYMINGTON applied steam to a side-wheel boat as early as 1788, and JOHN FITCH tried his steamboat on the "Collect Pond," in the city of New York, in 1796. OLIVER EVANS, in 1789, propelled his dredging-machine by a stern wheel on the Delaware and Schuylkill rivers.

This EDWARD WEST was a Virginian and settled in Lexington as a watch-maker in 1785. He died in the same town Aug. 23, 1827, aged 70 years. If he really had any valid claims as to priority of invention, it is curious that we hear nothing of them during the bitter legal controversy that took place between ROBERT FULTON, J. LANGDON SULLIVAN, and others before the death of WEST.

An Apparatus for Indicating an Excess of Water in Boilers.

A recent number of *Glaser's Annalen* has a description of an apparatus for showing an excess of water in boilers, the invention of RICHARD SCHWARZKOPFF, of Berlin. It consists of a tube r, the open lower end of which lies in the boiler on a level with the highest permissible water mark; this tube can be closed by the cock h. The upper end of the tube carries a head k in which a float s is placed. This is provided with an upright rod, so arranged



High Water Indicator for Boilers.

that any upward motion will press together two strips of spring brass lying directly above it.

As long as the water in the boiler remains at a proper level, viz., below the end of the tube r, steam will escape from the small cock in the head of the apparatus, and the springs will remain apart. But as soon as the maximum water level is reached the tube r and head k are filled with water, the float is raised and the lower spring pressed against the upper. The contact of these pieces is improved by two slips of platinum brazed to the brass, one slip on each piece. These springs are connected by wires and binding-screws p_1 and p_2 with an electric bell.

In this way it is possible to give a signal to the engineer in the engine room, or at a more distant place, of the excess of water in his boilers.

In nearly all previous inventions for this purpose the float has been placed in the boiler itself, where it was coated by boiler scale and tossed about by the motion of the boiling water. Observations of the interior condition of a boiler in use show that this motion is much more violent than is generally supposed to be the case. Therefore it was only natural that the parts in the boiler were soon destroyed. The inventor of the apparatus under consideration claims that none of these evils are felt in his indicator, since the only motions the float can have are a very small rise and a corresponding fall. There is also no injurious deposit of scale on the float, whereby it would be weighted, since the water in the boiler is raised into the head k but few times, steam usually filling it. The apparatus can be removed by closing the cock h and removing the bolts from the flanges directly above. In use, the cock in the head is kept very slightly open, in order that the water may rise in the tube r, when it reaches its maximum level.

Around the World in 30 Days.

In *Harper's Magazine* for November, Mr. LAFCADIO HEARN, in "A Winter Journey to Japan," tells how faster steamers and swifter trains may make it possible to discount PHINEAS FOGG's "80 days'" tour around the world by almost two-thirds The completion of the Trans-Siberian Ry. to Vladivostock is needed, however, for the realization of this later scheme.

Taking London for a starting point, with the railway mentioned completed, the following rates of time can be easily made:

	Days.	Hours.
London to Liverpool, by rail.....	0	5
Liverpool to Quebec, by steamer.....	6	0
Quebec to Vancouver, by rail, at 30½ miles an hour.....	4	0
Vancouver to Vladivostock by fast steamer, making 18 knots.....	10	18
Vladivostock to St. Petersburg, by rail, at 25 miles per hour.....	11	11
St. Petersburg to London.....	2	20
Total.....	35	6

But if the speed on the two great trans-continental routes be increased to 40 miles per hour, as it could be, at least 5 days could be deducted, and the actual time reduced to about 30 days.

"Electric Rock."

Truly is electricity the science of wonderful surprises. The latest discovery is reported from Syracuse, near where a deposit of solidified electricity has been found. This remarkable ore, which is called "electric rock," is said to contain a "hidden force that puzzles and astonishes all who see it, and expert electricians in particular." The last sentence is a trifle incongruous, because we should think that "expert electricians" ought to be the last persons to be puzzled and astonished by such a trifle as electric rock.

The properties claimed for this new material by its discoverer, however, are certainly calculated to astonish and puzzle even inexpert electricians It will generate unlimited power and give any amount of incandescent light, equal, if not superior, to that produced by *manufactured* electricity, in addition to which it is cheaper than kerosene. One small charge of 400 pounds of rock will produce light and power for one year before losing its force, and it is perfectly harmless, making insulation entirely unnecessary. These puzzling and astonishing claims are so broad and extensive that we can only conjecture that the birthplace of lightning must have been discovered at last.

One of the experiments made by the discoverer causes us to be just a trifle skeptical of the whole business. We read that a piece of the rock weighing half a pound was placed in a pint tumbler and the wires attached to a call bell, "which it caused to ring as loud as an alarm clock."

We scarcely think that a gentleman who is in the habit of using *pint* tumblers can be depended upon to make great discoveries, although, of course, that would depend a great deal upon the usual contents of the pint tumblers. In any case, the whole story looks uncommonly like one of the scientific fairy tales so frequently served up by the daily press.—*Electrical Review*.

Legal Decisions of Interest to Engineers.

Unsound Railway Ties.—It is a general rule that a railway company is bound to use the utmost care in having and keeping its appliances safe and sound, and in any action for injuries received by the derailment of a car, evidence that at the place of the accident the ties were "unsound," "decayed" and "rotton," shows such gross negligence that in addition to actual damages, exemplary damages by way of punishment may be recovered (Alabama G. S. Ry. Co. v. Hill, Supreme Court of Alabama, South. Rep., 90)

Damages to Abutting Property.—Where a railroad company constructs its line near the residence of the owner of land, he may recover for any damages he may sustain by reason of the operation of the railroad, which are not common injuries to all the public. Damages arising from smoke, soot and cinders from passing engines are proper elements of damages. (Omaha & N. P. Ry. Co. v. Janeck, Supreme Court of Nebraska, 46 Fed. Rep., 478.)

Liability of Lessor of Railroad.—When a railroad corporation having power to do so leases its line or any part thereof to another railroad company, the former is not in any way liable for the acts of the latter, if the absolute management and control passes with the lease. (Harper v. Newport & N. & M. V Ry. Co., Court of Appeals of Kentucky, 14 S. W. Rep., 346.)

Interpretation of Filling Contract.—Where a contract for filling in a trestle provides that payment shall be made by the "cubic yard of dirt," the contractor cannot recover for the space occupied by a culvert built by the company under the filling.—(East Tennessee, V. & G. Ry. Co. v. Matthews; Supreme Court of Georgia, 11 S. E. Rep., 841.)

Correction of Tables in Nystrom's "Mechanics."

A very serious error, but noticeable on account of its magnitude, has crept into the metric conversion tables of Nystrom's "Mechanics." The tables of acres into hectares and vice versa are interchanged in the editions revised by Prof. MARKS, making one hectare equal 0.4047 acres, instead of 2.4711 acres, as it should be.

THE HUDSON RIVER TUNNEL is being pushed as rapidly as possible from the New Jersey side; about 150 men are now employed and the progress is more rapid than formerly, being about 4 ft. a day. Some 350 ft. of iron tunnel is now finished in addition to the reconstructed portions of the old enterprise. Work on the New York side has practically ceased for the winter. The old tunnel has been strengthened and a bulkhead built at its end. The present intention is to build the shield for this heading on the shore and sink it into position in front of the bulkhead in the spring. Unless satisfactory arrangements can be made with the French steamship line, which rents the docks above the tunnel, this plan will not be possible, as the shield will have to be sunk directly in front of the entrance to their wharves, and the vessels will thus be prevented from using the docks for some time.

THE AUGUST WATER SUPPLY OF LONDON was 185,011,729 galls. daily for a population of 5,671,596; or an average daily consumption of 32.62 galls. per head for all purposes. Dr. FRANKLAND, in his report, says that organic carbon was present in the proportions of 0.024 to 0.250 units in every 100,000 units of water. The chemists of the water companies show organic carbon from 0.051 to 0.179 in every 100,000 units of water. The annual death-rate of London, from all causes, was 17.2, 16.7 and 17.4 in the last 3 weeks of August. In the metropolis of London the birth-rate was 28.6 and the death-rate 16.7 per 1,000 for the estimated population.

THE NEW CROTON DAM, as recommended by Chief Engineer FTELEY as a substitute for the proposed Quaker Bridge Dam, was practically decided upon by the Aqueduct Commission at its last meeting. The probable cost is $1,746,000.

ARTESIAN WELL INVESTIGATIONS are to be continued by the Agricultural Department, with Prof. E. S. NETTLETON in charge of the engineering and Prof. ROBERT RAY of Kansas in charge of the geological departments, while Col. RICHARD J. HINTON of Washington has charge of the collection and compilation of statistics, and the editing of the whole report. Work will be continued in North Dakota as long as the weather permits, then be taken up, successively, in South Dakota, Nebraska, Kansas, Indian Territory, New Mexico and Texas.

THE "IRON GATE" IMPROVEMENT OF THE DANUBE is, says the *Wiener Bauindustrie Zeitung*, to be substantially carried out upon the plans of the late WM. J. MCALPINE. These plans were prepared by him in 1870 for the Austrian Government, and involve the expenditure of $4,000,000. The Berlin Disconto Bank supplies the money, and the Luther Machine Co., of Brunswick, will excavate and blast out the obstructions in the 18-mile channel to be improved.

THE PHILDELPHIA GAS COMPANY has decided to no longer furnish gas as a fuel to the puddling furnaces of Pittsburg. This company supplied on Jan. 15, 1889, 750 different manufacturing establishments, including furnaces, glass houses, etc., and 24,000 houses. Since that date the consumption has grown enormously, and the present demand equals 500,000,000 cu. ft., equivalent to 25,000 tons of coal. The company claims that they have more gas than ever, but the demand from the more valuable source of income, the private residences, is also far greater, and the gas can be thus used to greater advantage than at the very low fuel price to mills at present ruling. The company has also decided to go into the illuminating gas business on an enormous scale. The Philadelphia Company has a capital of $15,000,000, with Mr. GEORGE WESTINGHOUSE at its head. The change of plant will cost the manufacturing establishments much money, and the use of coal would increase the cost of production. But, on the other hand, coal mining will be extended and mines reopened that have been closed for some years, and the manufacture of artificial fuel gas will receive more serious attention.

THE USE OF NATURAL GAS IS TO BE DISCARDED by the Cambria Iron Works and coal again substituted for it. The Cambria company has extensive coal mines near Johnstown and has now a large force at work in opening them up. The reason given for this disuse of natural gas is its inconstancy; it cannot be relied upon. As the Pennsylvania company has already shut down the supply of gas to the Pittsburg puddling furnaces, there will be a sufficient supply for domestic consumption and minor uses.

THE EXCURSIONS OF THE BRITISH IRON AND STEEL INSTITUTE and the *Verein Deutscher Eisenhuettenleute* in the United States were concluded this week. Our account in this issue of the tour through the South takes the party as far as Chattanooga Tuesday, Oct. 21, was spent at the new town of Middlesborough, near Cumberland Gap. From that point the excursion traveled through Virginia, visiting the furnaces at Pulaski, the Great Outburst iron mine on the North Carolina extension of the Norfolk & Western, the coal mines at Pocahontas, and Luray Cave, in the Shenandoah Valley. Saturday and Sunday, Oct. 25 and 26, were spent in Washington. Here the party was joined by most of those who took the Northern excursion through the iron and copper mines of the North Michigan peninsula, and thence east via the Sault Ste. Marie and Niagara Falls. On Monday the whole party went to Sparrow's Point, Md., near Baltimore, and visited the new works of the Pennsylvania Steel Co., now being constructed there.

A considerable number of the excursionists came on to New York the same afternoon, some of them sailing for home on this week's steamers, but the majority accepting the invitation of the Thomson-Houston Electric Co. to visit the electrical works at Lynn, Mass., on Wednesday, Oct. 29. Nearly 300 of the party, however, went from Baltimore to Niagara Falls, spending Tuesday at the latter place, and starting Wednesday on the excursion tendered by the Canadian Government to visit Toronto, Ottawa, Montreal and Quebec.

IMMIGRATION continues to increase, and is very large, a sure indication of probable "good times" for some months at least. For September it is 18 per cent. larger than last year; for the seven months ending with September, 12 per cent. larger. The increase is largely from Italy and Poland, but less decidedly so than it was some months ago. British emigration now constitutes about one-fourth instead of one-third of the whole. The Canadian emigration is not recorded, owing to lack of provisions for accurate records, but is really something like one-sixth of the total immigration, there having been in 1880 nearly as many Canadians as English and Scotch living in this country.

THE WORLD'S FAIR LAKE FRONT SPECIFICATIONS call for the filling in of an area of about 44 acres, to be first inclosed by a revetment 4,300 ft. long. An area of 45 acres more is to be filled. The revetment will be made of white oak piles driven 4 ft. apart, capped by 12×12-in. timber and tied with 12×12-in. and 6×12-in. waling pieces. Sheet piling, 6×12 ins., will be driven in a double line, with fender piles, anchor piles, etc. The filling is to sand, gravel or clay; bids to cover so much per acre raised 9 to 9½ ft. above city datum; and the contractor must, without further compensation, keep the surface to the required level for one year after the first completion of the work. Work must be done to a height of 6 ft. by April 15, 1891, and to 9 ft. by July 31, 1891.

THE LATEST PHENOMENAL BIT OF ARCHITECTURE contributed in the guise of "a memorial tower of the World's Fair," combines a 400-ft. globe revolving in a base of eccentric design, a Chicago 16-storied business block on top of that and ending in a facsimile of the Eiffel Tower, capped, of course, with a colossal statue of COLUMBUS. This exceedingly wild architectural dream is equipped with concert and lecture rooms, with a seating capacity of 25,000 people, electric railways, elevators, four "grand hotels," and, last but not least, a *carriage way* providing for "bicycle racing and trotting matches." Chicago is still ahead.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Pennsylvania.—A large force of men is at work on the line from Duquesne, Pa., to various manufacturing establishments in and around McKeesport.—It is announced that negotiations have been completed for the purchase of the Toledo, Peoria & Western R. R.

Michigan Central.—The engineers of this company have completed surveys for a railway from Bay City to Sebewaing, Mich., and efforts are being made by the people along the route to secure the construction of the line.

Rumford Falls & Buckfield.—Work will begin at once on the extension of this road from Canton to Rumford Falls, Me.

New York Central & Hudson River.—This company will expend about $400,000 in improving its terminal facilities at Thirtieth St., New York City.

Baltimore & Ohio.—Grading is nearly completed and tracklaying will commence in 90 days on the Chicago & Akron Junction R. R.

Louisville, New Albany & Chicago.—At the annual meeting recently held the directors voted to build two extensions. One will be built into the Brazil coal fields of Indiana, and the other will be an extension of the Orleans, West Baden & French Lick branch to Evansville, Ind., a distance of 80 miles. Work on these extensions is to be begun at once, and it is probable that the lines will be built by independent companies in the interest of the L., N. A. & C. Ry. During the last fiscal year the condition of the roadbed and equipment has been greatly improved. About 6,000 tons of new steel rails have been laid, and the equipment has been increased by the addition of 15 new locomotives and 500 new cars. It is proposed during the coming year to lay 95 miles with 67-lb. steel rails.

Clarendon & Pittsfield.—The grading has been completed and one mile of track has been laid on the extension from Center Rutland to Rutland, Vt., 2 miles. The road is being built by the Vermont Marble Co. and will open up marble quarries along its route. G. C. Robinson, of West Rutland, Vt., is Chief Engineer.

Quebec Central.—A correspondent sends us the following:

A corps of 16 engineers are surveying a line from Tring Station south to a connection with the Canadian Pacific Railway at Lake Megantic. The surveys have been completed for about 30 miles and a very favorable line has been secured. The grades and curves are generally easy and the work light. There are only a few bridges and these are mostly of short span. The road will be laid with 80 lb. steel rail and the track will be first-class in every respect.

Projects and Surveys.

Farmington & Gardiner.—Two routes have been surveyed for this Maine railway, but the one selected will probably be that passing through Manchester. The work will be very easy. The total distance from Farmington to Gardiner, Me., will be about 35 miles, and it is estimated that a narrow guage road can be built and equipped for $5,000 per mile.

Oneida, Oneonta & New York.—At the annual meeting recently held the following officers were elected: J. W. Warner, of Oneida, N. Y., President; D. P. Wilber, Treasurer, and W. A. E. Tomkins, of Oneonta, N. Y., Secretary. The company proposes to build a railway connecting Oneonta and New Berlin, N. Y., with Oneida, N. Y., a distance of 65 miles.

SOUTHERN.—Existing Roads.

Florida Midland & Georgia.—Arthur Pew, of Dublin, Ga., Chief Engineer, writes as follows:

This road is projected to run from Valdosta, Ga., to Madison and Dean man's Bay, Fla. The line has been located and the grading nearly completed from Valdosta to the Florida line. Two preliminary surveys have been run for the remainder of the line, and location will begin in November. The work is generally light; maximum grade, 42 ft. per mile, and maximum curve 6°. There will be an iron bridge of 125 ft. span over the Withlacoochee River. The principal business will be in lumber phosphate, naval stores and general merchandise. About 75 men are now at work on the grade. Tracklaying will begin Nov. 15.

Wrightsville & Tennille.—Arthur Pew, of Dublin, Ga., Chief Engineer, writes as follows.

The Wrightsville & Tennille R. R. Co. has at present 35 miles of railway in operation, and proposes to extend its line from Dublin to Abbeville, Ga., a distance of 50 miles. The preliminary survey has been commenced. The route is through a fine timber country, which will furnish a large business in lumber, naval stores, cotton and farm produce. The work will be light; maximum grade about 1% and maximum curve about 6°. There will be a bridge over the Oconee River. This being a navigable stream, a draw will be required. The plans are now before the Secretary of War, and as soon as they are approved contracts will be let.

Tennessee River, Ashville & Coosa.—T. M. T. McKennan, of Ashville, Ala., Chief Engineer, writes as follows:

This road is projected to run from Lock No. 3, on the Coosa River to a point on the Tennessee River, via Greensport and Ashville, a distance of about 100 miles. The route is now being located from Ashville east toward the

Coosa River, and the preliminary surveys are in progress from Ashville northwest toward Decatur, Ala. Three miles of the grading from Ashville to Whiting are about completed and the track will be laid at once. The principal business of the road will be in iron ore, coal, timber, limestone and farm products.

Richmond & West Point Terminal Co.—A press dispatch says:

It is stated on the best authority that the Richmond & West Point Terminal Co. will secure a through trunk line from Norfolk, Va., to Cincinnati, O. The line proposed is from Norfolk to Stanhope, Nash Co., N. C., which is already built jointly by the Richmond Terminal and the Atlantic Coast Co. A new road from Stanhope to Raleigh, 30 miles, will connect with the regular line to Wilkesboro. From Wilkesboro a road, which is now being built, will connect at Bristol, Tenn., with the South Atlantic & Ohio, which is being pushed on in the direction of Cincinnati. All connecting links between these lines will be built immediately, and through trains will be put on. At Bristol the road will connect with the East Tennessee line, which is owned by the same company, and then a through line to the South will be secured. This road will bring the Pocahontas coal beds 50 miles and Raleigh 40 miles nearer Norfolk than now.

Charleston, Cincinnati & Chicago.—P. P. Dickinson, Chief Engineer of the Construction Co., is reported as saying that the grading is being carried on along practically the entire line between Newberry and the Broad River crossing, about 55 miles, on the line from Blacksburg to Augusta, Ga. About Nov. 1 the quarrying of stone for the masonry required on the route will begin, and it is expected that by February the shaping of the stone will be sufficiently completed to permit the work on the bridge abutments to begin. The superstructures for bridges over the Broad, Thicketty, Pacolet, Tyger and Enoree rivers will be of iron, and have been ordered from the Phœnix Bridge Company, of Phœnixville, Pa. The 60½-lb. steel rails for the entire division have been contracted for with the Bethlehem Iron Company, of Bethlehem, Pa. It is expected that the line from Blacksburg to Newberry, 71 miles, will be ready for the rails next spring or early in the summer. The construction of the line will be pushed forward as rapidly as possible, and no delays are expected

Wilmington, Chadbourn & Conway.—W. H. Chadbourn, Jr., of Chadbourn, N. C. Chief Engineer writes as follows:

About 200 men are at work on the branch of this road from Chadbourn, N. C. northwest to the plant of the Enterprise Land & Lumber Co., a distance of 11 miles. One mile of the grading has been completed and 3 miles of the right of way have been cleared. It is expected that tracklaying will begin about Nov. 1, and that the road will be completed by Dec. 31. The work is light; maximum grade, 26 ft. per mile and maximum curve 3°. The rails will be 45 lbs. per yard. The Chief Engineer is in charge of the work.

Projects and Surveys.

Blacksburg.—W. E. Hubbert, of Blacksburg, Va., writes as follows:

No surveys have yet been made for this road nor the route decided upon, but the road will probably run from Blacksburg, Va., via Lafayette and Salem, Va., to Roanoke, Va., a distance of about 32 miles. Good progress has been made in securing right of way and about $10,000 in other local aid has been obtained. The principal business will be in coal, cattle, hay and general merchandise. J. F. Christian, of Roanoke, Va., is President.

Savannah & Riverside.—This company is being chartered to build a railway from Savannah, Ga., over Wilmington Island.

Dalton & Spring Place.—A railway is to be built from Dalton to Spring Place, Ga., 14 miles. Frank T. Reynolds, Dalton, Ga.

Charleston, Kentucky & Western.—Engineers will soon be put into the field to survey the route for this Kentucky railway.

NORTHWEST.—Existing Roads.

Chicago & Western Indiana.—At a recent meeting of the stockholders it was decided to make an issue of bonds amounting to several million dollars. The proceeds are to be used in improving the terminal lines. The belt line is to be generally improved and extended to make connections with various industries in the suburbs of Chicago. The station at Polk St. will be enlarged and the freight yards and depots increased. Work is to begin at once.

Chicago & Alton.—This company is reported to have purchased the Kansas City & Southern R. R., running from Kansas City to Osceola, Mo., 111 miles.

Union Pacific.—The construction of a branch from Omaha, Neb., to Sioux City, Ia., is rumored.

Chicago, St. Paul & Kansas City.—This company is considering an extension from Des Moines, Ia., to Omaha, Neb. An official is quoted as saying:

"We are considering several routes, one running south of the Rock Island, through the southern tier of Iowa counties, and another north of the Rock Island. We have not decided which to select, but will use one, and that in a very short time."

Chicago, Milwaukee & St. Paul.—This company has decided to commence work soon on the proposed line from Howard to Huron, S. Dak. The right of way and the necessary terminal lands have been secured.

Winona & Southwestern.—Tracklaying is now completed to a point within 35 miles of Spring Valley, Ia. About 30 men are now laying track, and this force will be increased so as to lay two miles per day.

Burlington & Missouri River.—It is intended to begin work soon on the extension from Oberlin, Kan. to Pueblo, Colo., noted last week as under survey.

Duluth & Southern.—Contractors are now examining the section from Duluth, Minn., to Walbridge, Wis., preparatory to making bids for construction.

Projects and Surveys.

Ontario & Rainy River.—Tenders will be received until Jan. 19, 1891, for the construction and equipment of this railway up to the Government standard, from Sand Lake, Ont., to the mouth of Rainy River. Seventy miles of the line are to be completed by Dec. 31, 1891, and the whole line finished in 3 years from that date.

Bowdle & Forest City.—The construction of a railway from Bowdle to Forest City, S. Dak., and thence to Rapid City, S. Dak., is talked of.

Dakota, Wyoming & Missouri.—Right of way and local aid are being secured for this road. Wm. F. Coad, of Rapid City, S. Dak., is interested.

Midland Pacific.—Arrangements are being made to continue the survey of this road from Pierre, S. Dak., west through the Black Hills.

SOUTHWEST.—Existing Roads.

Kansas City, Nevada & Fort Smith.—Tracklaying is making good progress on this Missouri road.

Weatherford, Mineral Wells & Northwestern.—Tracklaying is progressing on this Texas road at the rate of 1½ miles per day.

Mississippi & Little Rock.—About 30 miles of track have been laid on the line from Duncan to Little Rock, Ark., 61 miles.

Missouri, Kansas & Texas.—The contract has been let to John P. Hughes for building the line from Waxahatchie to Hillsboro, Tex., 35 miles. Work will be begun at once.

Natchez, Red River & Texas.—It is stated that this road running from Vidalia to Black River, La., 25 miles, is to be changed to standard gauge and will probably be extended to Alexandria, La.

Projects and Surveys.

Dallas & Fort Worth.—A company has been organized to construct a railway from Dallas to Fort Worth, Tex., a distance of 32 miles. Work is to begin at once. E. E. Perkins, of Hartford, Conn., is interested.

San Angelo, Abilene & Henrietta.—A charter has been applied for by this company recently organized. The officers are: President, E. H. East; Vice-President, John Bowyer; Secretary and Treasurer, D. M. Devitt; General Manager, A. D. Goodenough. Work is to commence at once.

ROCKY MT. AND PACIFIC.—Existing Roads.

Denver & Rio Grande.—Tracklaying has been completed on the line from Alamosa to Villa Grove, Colo., 54 miles.

Coos Bay, Roseburg & Eastern.—The force now grading this road from Marshfield to Roseburg, Ore., is to be increased. Rails sufficient for 30 miles of track are being shipped and this amount of track will be completed by April 1.

Atchison, Topeka & Santa Fé.—The Board of Directors has approved the purchase of the Colorado Midland R. R.——An official of this company is quoted as saying that no extensions will be built soon. —Dispatches state that surveys have been completed from Rogers Station, on the Atlantic & Pacific R. R., to Crain's Lake, 70 miles. The survey is now being continued north to Bakersfield, Cal. Work, it is stated, will begin about Jan. 1, 1891. there will be one tunnel on the line 1,600 ft. long. From Fresno, Cal., to San Francisco, Cal., it is stated that the San Francisco & San Joaquin Valley R. R. will be used.

Great Northern.—Tracklaying is being pushed on the Fairhaven & Southern R. R. to the boundary, and the line will be completed in a few weeks.——Grading has been completed from Sedro south 5 miles, and 30 miles more will soon be placed under construction.——The coal mine branch running from the main line, about 3 miles south of Sedro, will be completed in about one month. The line is 4 miles long.

Union Pacific.—The Elgin branch, 21 miles long, is now nearly completed.——About 3,500 men are at work on the line from Portland, Ore., to Seattle, Wash., and about 25% of the grading has been completed. There is considerable heavy work on the line.

Northern Pacific.—Track has been laid from Lakeview, Wash., west to the Nesqually River, 3 miles, and grading is being pushed on the division from the Nesqually to Olympia, Wash. A Howe truss bridge, 166 ft. long, will be built across the Nesqually.

Southern Pacific.—The right of way has been secured gratis for the line from Santa Margareta to Elwood, Cal., and, according to the agreement entered into some time ago, work will be commenced at once. The construction of the line will be quite expensive, there being several tunnels and a large amount of cutting. The longest tunnel will be that between Santa Margareta and San Luis Obispo, 7,000 ft., and penetrating solid rock. It is expected that it will take about 18 months to complete the line.

San Diego, Cuyamaca & Eastern.—It is reported that work will soon be commenced on an extension from Lakeside, Cal., to Salton, on the Southern Pacific R. R.

Projects and Surveys.

Los Angeles Terminal.—F. B. Burnett, of Los Angeles, Cal., writes as follows:

This road is projected to run from San Pedro, Cal., through Los Angeles to Hueneme, Cal., with branches to Pasadena, Altadena and Long Beach, a total distance of 140 miles. The surveys are now in progress. About 20 miles will be mountain work; maximum grade 2 %, and maximum curve 8°. About one half of the right of way has been secured. The officers are: President, B. F. Hobart, of St. Louis, Mo.; Vice-President and General Manager, F. B. Burnett, and Chief Engineer, W. F. McClure.

San Diego, Phœnix & Galveston.—Chartered in California to build a railway from San Diego Bay to the eastern boundary of California near Yuma, Ariz.

Wyoming, Salt Lake & California.—The Salt Lake City Council has granted this company right of way through the city for 20 years. The road is projected to run from Evanston, Wyo., west through the city to Deep Creek and the Nevada State line. The money necessary to build and equip the road is said to have been secured, and it is stated that construction will commence soon.

Columbia River Ry. & Navigation Co.—This company has been chartered in Oregon to build a railway from the mouth of the Columbia River, along its north bank to the mouth of the Okanagon River; to build a portage railway from the Columbia River near the mouth of the Klickitat River to a point near Columbus, Klickitat Co., and to operate a line of steamboats and other craft on the Columbia and Williamette rivers. The principal offices will be at Tacoma.

CITY TRANSIT.

Electric Railways.—***Providence, R. I.*** The Committee on Railroads of the City Council has reported in favor of granting the Union R.R. the right to operate its lines by the overhead trolley system.

Sharon, Pa.—An electric railway company was formed here Oct. 22, to build a 4-mile line to Sharpsville.

Philadelphia, Pa.—Extensions are proposed by the People's Passenger Ry. and the Traction Co.

Braddock, Pa.—The Braddock Electric Street Ry. has received permission to build a line through the town to connect with the Duquesne Traction Co. at Wilkinsburg.

Wheeling, W. Va.—Newspaper reports state than an electric line will be built to Martin's Ferry by the Construction Co. of the latter city.

Parkersburg, W. Va.—The consolidation of the Parkersburg Electric Light Co. with the Park City Street Railway Co. and the operation of the street railway by electricity is proposed.

Birmingham, Ala.—The Birmingham Railway & Electric Co., controlling a number of lines in this vicinity, has filed a $1,500,000 mortgage with the Central Trust Co. of New York in order to secure funds for changing the motive power to electricity.

Jackson, Miss.—The Jackson Land & Improvement Co. is reported as about to construct a 3-mile line.

Chattanooga, Tenn.—The North Chattanooga Ry. is reported as negotiating for an electric plant to replace its present horse system.

Youngstown, O.—An electric line connecting the city with Hazelton, O., is now being constructed by the Youngstown Street Railway Co. About six miles of track will be laid. The rails will be furnished by the Johnson Co., Johnstown, Pa. Part of the other appliances have been purchased. The officers are: Joseph Karmalee; Secretary, William Cornelius, Singleton. A. King is the engineer in chief of construction.

Ashtabula, O.—W. W. Hazzard, Cleveland, O., has been granted a franchise for putting in an electric railway. Construction work is to be commenced soon, and the line will probably be in operation early next summer. Four miles of rails will be laid. The line is to extend from the city to the harbor and through the principal streets. The steam power plant will be of 100 HP. The Johnson Co., of Johnstown, Pa., will furnish the rails. Only part of the electrical appliances have been purchased. A company with a capital stock of $125,000 is to be formed to operate the road.

Chicago, Ill.—The South End Electric Ry., recently incorporated with a paid-up capital of $100,000, will be laid with 70-lb. girder rails. The leading stockholders are L. M. and C. E. Loss. The former had charge of the masonry of the Cairo bridge for the Illinois Central R. R., and is now similarly engaged on the Mississippi bridge at Memphis. C. E. Loss is a well-known Western contractor for street railway systems.

Morgan Park, Ill.—The South Chicago Electric Ry. has petitioned for right to extend its system into this town.

Milwaukee, Wis.—Newspaper reports state that electricity will probably be used on the Milwaukee City and the Cream City street railways. The Sprague system will be adopted, and the cost of the change is estimated at $2,000,000, there being over 100 miles of track to be relaid with heavier rails.

Clinton, Ia.—The Baldwin Electric Co. has applied for a franchise to build and operate a line to Lyons. The Clinton & Lyons Horse Ry. has also applied for right to adopt electricity on its 10 miles of line.

Sioux City, Neb.—The Lincoln Street Ry. will be converted to an electric line. Work on the power station will begin soon, and it is hoped that the line will be completed before snow falls.

Houston, Tex.—S. Taliaferro and others propose building an electric railway to the new town of South Houston.

Galveston, Tex.—The Rae system of propulsion will be used on the Galveston City Co.'s lines.

Denver, Colo.—The Colfax Ave. Electric Ry. has voted to build 10 miles of new lines.

Ogden, Utah.—The Ogden Street Ry. has been sold to the Jarvis-Conklin Trust Co., of Kansas City. The latter company has invested over $500,000 in the Ogden waterworks and $1,500,000 in the Bear River canal.

Oakland, Cal.—E. W. Meeks, C. E. Palmer, W. J. Landers and others have received a franchise to construct an electric railway to Haywards.

Astoria, Ore.—The Electric Power & Transit Co. intends to build an extensive system in Clatsop County.

Horse Railways.—*Asheville, N. C.*—The Asheville Loan, Construction & Improvement Co. has applied to the board of aldermen for the right of way to construct a street railway.

Albany, Ga.—Nelson Tift will soon commence building a street railway.

Bay St. Louis, Miss.—The construction of a street railway is proposed.

St. Paul, Minn.—It is reported that the Wage Earners' Co-operative Home Association will build a line to its property near Lake Owasso.

Dummy Railways.—*Ringgold, Ga.*—The survey of the line to Catoosa Springs has been finished, and construction will begin as soon as the right of way is secured.

Fort Worth, Tex.—The City Council has granted a franchise to the Fort Worth & Dallas Rapid Transit Steam R. R., provided the line be constructed within 1 year and operated at least 5 years.

Elevated Railway.—*Chicago, Ill.*—The Lake Street Elevated R. R. has at last received permission from the City Council to use double tracks in place of the Meigs system.

Inclined Railway.—*Kansas City, Kan.*—The Common Council has requested the Council of Kansas City, Mo., to grant a franchise for an inclined road between the two cities.

New Companies.—Henrietta, Tex., Street Ry.; capital stock $100,000; incorporators, W. J Swain, F. L. Miller, D. C. Patton and others. Whitesborough, Tex., Street Car Co., Cicero & West Chicago Electric Street Ry., Chicago, Ill.; capital stock, $1,000,000; incorporators, J. Feldman, H. Vanderpoel, J. B. Heffernon. Union Electric Ry., Helena, Mont.; capital stock, $500,000; incorporators, N. W. McConnell, A. M. Thornburgh, E. C. Richards and others.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Hartland, Me.*—A bridge is to be built at this place; E. J. Webber, Hartland.

McKeesport, Pa.—Bids will be wanted in about two weeks for material, etc., for 600-ft. highway bridge. S. C. Weiskopf, Penn Building, Pittsburg.

Pittsburg, Pa.—A large four-track bridge is to be constructed over Sixth Ave. by a stock company.

Pittsburg, Pa.—Chief of Department of Public Works E. M. Bigelow informs us that contracts will be let in February, 1891, for constructing a new bridge in the park 600 ft. long by 80 ft. wide.

Wallingford, Pa.—It is reported that a bridge is to be built over the Allegheny River to connect this town with Island Park.

Hamilton Co., O.—Bids will be received until Nov. 22 for a wrought iron bridge across Sycamore Creek, on the Loveland and Madeira road, Symmes Township; a wrought iron truss bridge on the West Fork road, at Bachelor's, Millcreek Township; a wrought iron truss bridge on West Fork road, at Hahn's, Millcreek Township, the work to be done according to the plans and specifications now on file in the office of the Board of Hamilton County Commissioners; John Hagerty, Auditor, Hamilton Co., O.

Youngstown, O.—A bridge to cost $100,000 is to be built over the Mahoning River at this place.

Chattanooga, Tenn.—It is reported that a terminal company has been organized, and will build a double-track railway bridge across the Tennessee River.

Alexandria, La.—The iron bridge across the Red River, to connect Alexandria with Pineville, will cost about $60,000, one-half of which has been subscribed.

Little Rock, Ark.—It is stated that the bridge to be built across the Arkansas River to Argenta, will cost about $200,000.

Vancouver, Wash.—The steel bridge across the Columbia River at this place will be 6,000 ft. long and will cost $1,000,000. It will have a 200-ft. draw.

Tunnels.—The Canadian government has been asked to aid in the construction of a tunnel across Northumberland Straits to Prince Edward Island. The preliminary surveys have been completed. The distance between Prince Edward Island and the mainland is 6¼ miles. The cost of the work is estimated at $17,000,000. An English syndicate has offered to construct the tunnel if the Canadian government guarantees 6% interest on the bonds for 100 years.

WATER-WORKS.

NEW ENGLAND.

Brewer, Me.—The Penobscot Water & Power Co., according to the Bangor *Industrial Journal*, has nearly completed water-works to supply the city of Brewer and the towns of Veazie, Oldtown, Milford and Orono. Contracts have already been made to supply Brewer, Oldtown and Veazie.

Franklin, N. H.—A citizens' vote will be taken on the establishment of water-works.

Greenville, N. H.—The works are nearly ready for use. The mains will be connected with the pumps of the Columbian Co.

Chicopee, Mass.—A reservoir on Hog Hill is advocated in connection with the proposed city works.

North Brookfield, Mass.—By a vote of 248 to 78 the town has voted to establish works. An appropriation of $1,000 for preliminary surveys has been made and Theodore C. Bates, Francis Batcheller and Alden Batcheller have been appointed as water commissioners.

MIDDLE.

Albany, N. Y.—Three new storage reservoirs have been completed, one on Sand Creek, with a capacity of about 9,000,000 galls.; one on Patroon Creek with a capacity of 16,300,000 galls.; and the third above Tivoli Lake, with a capacity of 19,000,000 galls. The last, or Tivoli reservoir is below the others, is connected with them by supply mains, and serves as a supply reservoir.

Holley, N. Y.—The works were tested October 23.

Huntington, L. I., N. Y.—The Huntington Water Works Co. has been incorporated with a capital stock of $15,000. James M. Brush, Douglas Conklin and Charles P. Holmes are among the incorporators. The projected supply is from springs.

Syracuse, N. Y.—The purchase by the city of the works of the Syracuse Water Co. is under consideration.

Yorkshire Center, N. Y.—Works are projected.

Grove City, Pa.—Works are projected. Address William Young or Captain Craig.

Scottdale, Pa.—S. F. Potter, Superintendent, informs us that the works will be put in operation Jan. 1.

Braddock, Pa.—A reservoir of 4,000,000 gal. capacity will probably be constructed within city limits next spring.

Beaver, Pa.—Union Water Co. expect next season to put in a filtration plant, increase pumping capacity, and lay mains to supply Beaver Fall, New Brighton and vicinity, covering population of 30,000.

Homestead, Pa.—City has voted bonds to build its own works next summer; 10 to 15 miles of mains will be laid, reservoir constructed, and 3 or 4-million gal. pumping engine purchased.

McKeesport, Pa.—A new 6,000,000-gal. high duty pumping engine will probably be put in next spring.

Turtle Creek, Pa.—The works to supply this town, Wilmerding and Briton have been completed. A 4,000,000-gall. Worthington triple expansion pumping engine will be used.

SOUTHERN.

Buchanan, Va.—The Central Land Co., which is developing a town here, has projected works to take their supply from springs about 5 miles distant. The scheme includes a 4,000,000-gall. reservoir about 135 ft. above the hotel site and 240 ft. above the river.

Eagle Rock, Va.—T. B. Jackson, Cincinnati, is President of the Craig Valley Co., and G. K. Anderson, Secretary. The company has projected water-works.

Shenandoah, Va.—Works are soon to be put in by the Shenandoah Land & Improvement Co.

Americus, Ga.—The following is from Geo. G. Earl, City Engineer:

About 6 miles of 6 and 4-in. mains are being laid and a like amount of the same size will be added at once. An artesian well has been contracted for. There is some doubt as to its success and a supply from a creek, filtered, has been proposed.

Atlanta, Ga.—The citizens have voted by a large majority to issue $250,000 water-works improvement bonds.

Smithville, Ga.—Works are projected.

Bluffton, Ala.—The Bluffton Land, Ore & Furnace Co. are interested in works projected here.

Montgomery, Ala.—The company has chosen M. M. Tidd, Boston, Mass., as its arbitrator to determine the price the city shall pay for its plant.

Oneonto, Ala.—Address the Oneonto Land & Improvement Co. regarding the proposed water-works.

Athens, Tenn.—Extensions are under consideration or ordered.

Jasper, Tenn.—A water-works company has been organized.

NORTH CENTRAL

Zanesville, O.—J. W. Hill, Cincinnati, O., has reported upon the present condition and needs of the works. He recommends the purchase of two 3,000,000-gall. pumps, two 20-in. mains between the reservoirs, a new stand-pipe for high service and some new distributing mains. The estimated cost of the improvements is $175,000. A vote is to be taken at the November election on the issuance of $175,000 of water-works bonds. At present the city is short of water, owing to repairs which are being made to some of the engines, and some of the water now being furnished is said to be contaminated with sewage.

London, O.—We have received from John P. Martin, Manager of the Ohio Valley Water & Contracting Co. a description of the works built at this place by the above-named company. The supply is from three wells, two of which are flowing. A full description of the works will be given in the 1891 MANUAL OF AMERICAN WATER-WORKS.

Mishawaka, Ind.—The time for receiving bids for pipe, specials, hydrants, valves and valve-boxes, as noted in our issue of Oct. 18, has been extended to Nov. 12. Address W. H. Dodge, President Mishawaka Water-Works Co.

Imlay City, Mich.—The mains are being laid.

Belleville, Ill.—The City Water Co. proposes to construct an additional storage reservoir.

Lake Forest, Ill.—Clarence Buckingham is President, E. F. Chapin, Secretary, and Joseph T. Bowen, Treasurer of the water company. Subscriptions to the amount of $50,000 have been paid in and bids for works are now wanted.

NORTHWESTERN.

Council Bluffs, Ia.—It is reported that a stand-pipe will be added to the works.

Rockford, Ia.—The town has voted 3 to 1 in favor of water-works.

Alliance, Neb.—Plans for $20,000 water-works are being prepared by A. A. Richardson, Consulting Engineer, Lincoln, Neb.

SOUTHWESTERN.

Arkadelphia, Ark.—Bids for water-works are wanted by G. W. Corden.

Temple, Tex.—The new 20 × 120-ft. steel stand-pipe burst and fell Oct. 25. Further particulars are given elsewhere in this issue.

Denver, Col.—The Citizen's Water Co. is ready to supply water in a part of the city.——The East Denver Water Co. will purchase one mile of extra iron pipe, and lay it in Aurora and New England Heights.

PACIFIC.

Kettle Falls, Wash.—About $15,000, it is reported, will be expended for water-works in this new town. The supply will be from a spring.

Sellwood, Ore.—A water company, with a capital stock of $35,000, will soon be incorported by Richard Leaman, William I. Ball and George P. Dorris. The supply will be from wells. The franchise is for 50 years and the company has exclusive privileges for 25 years. The supply will be from wells, and water for fire protection will be furnished without charge.

Ogden, Utah.—The Bear Lake and River Water-Works & Irrigation Co. are about ready to supply the city from their new gravity plant.

CANADA.

Toronto, Ont.—The water-works by-law for the raising of money to improve the works has been defeated.

ARTESIAN WELLS.

Somerville, Tenn.—Bids for sinking an artesian well are wanted by Thomas B. Yancey, Mayor.

Dallas, Tex.—Address Webster & Wood regarding an artesian well to be sunk on Caruth Heights.

Tyler, Tex.—It is reported that wells will be sunk in the Rowland addition by E. N. Orkney.

Waco, Tex.—A well will be sunk by Thomas Padgitt.

Whitesborough, Tex.—A well will be sunk by the Whitesborough Artesian Well, Water, Coal & Gas Co.

Alamosa, Col.—A large flow of water has been secured at a depth of 675 ft. It is said that it will be used for power in connection with a flouring mill.

IRRIGATION.

Bozeman, Mont.—The Excelsior Canal Co., has been incorporated to supply water for irrigation in Gallatin Co. Capital stock, $50,000.

Laredo, Tex.—It is reported that the North Laredo Land, Immigration & Water Co. is constructing irrigating.

Leadville, Col.—The property of the Oro Ditch, Flume & Land Co. has been purchased by C. N. Priddy, F. W. Owens and J. M. Maxwell. The property consists of a ditch 8 miles long and 1,500 acres of land. The new company proposes to put in a water and electrical power plant in the spring, and to make other improvements.

Tulare, Cal.—The Directors of the Tulare Irrigation District, J. W. Mackie, President; E. Oakford, Secretary, offer for sale until Nov. 17, $200,000 11-20, 6 % bonds.

Garfield, Utah.—A canal from Utah Lake along the bench to this town is under discussion.

Eagle Rock, Ida.—The Idaho Canal Co. will complete 35 miles of their canal within a few months. The line extends from 14 miles above Eagle Rock to 8 miles east of Blackfoot.

SEWERAGE AND MUNICIPAL.

Sewers have been ordered at Pittsburgh, Pa.; Atlanta, Ga., costing $40,000; Duluth, Minn., storm sewers; Portland, Ore.

Providence, R. I.—Sewer construction is progressing slowly on account of the scarcity of good laborers. Commissioner Coleman will probably buy a portable stone crusher for use on the work as the present crushing and screening plant is inadequate.

Buffalo, N. Y.—The plans for the east side sewerage system, prepared by Emil Kuichling, have been approved by the Sewer Committee, which recommends that a consulting engineer be called in to report on them. Ordinances have been introduced for two stone sewers costing $79,000.

Rochester, N. Y.—A number of extensive pipe and stone sewers, costing about $80,000, are under discussion in the Common Council.

Suspension Bridge, N. Y.—A new sewerage system has been adopted by a vote of 118 to 82.

Pittsburg, Pa.—City Engineer W. R. Browne informs us that the new two-mile sewer which has been in the course of construction for two years will be completed in about three months. It varies from 8 to 2¼ ft. in diameter. A new sewer about 3 miles long and 9 ft. in diameter at the largest point will be contracted for next year.

Max Meadows, Va.—A sewerage system and waterworks are proposed by the Land & Improvement Co.

St. Louis, Mo.—Sewer Commissioner McMath is preparing plans for separate sewers over a large section of the city.

San Francisco, Cal.—The sewerage system for the Port Lobos district, proposed by City Surveyor Smith and approved by Rudolph Hering has been adopted by the supervisors.

Street work has been ordered in the following cities: Syracuse, N. Y., grading; Pittsburg and Allegheney, Pa., grading and paving; Kansas City, Mo., asphalt on concrete.

New York City.—In his report for the quarter ending Sept. 30, Thos. F. Gilroy states that the present area of paved streets is 8,343,886 sq. yds., and the length 361.19 miles. The number of excavations made in the public streets by private corporations and individuals during the three months was 7,037; 14.4 miles of gas mains were laid, 18.26 miles of electric subways built and 5,493 lin. ft. of double rail tracks laid. There were 1,893 lin. ft. of sewers and 6 receiving basins built, making the present extent of the system on Manhattan Island 436.58 miles of sewers, with 5,229 receiving basins.

Newark, N. J.—A large amount of square and oblong trap rock and asphalt paving is proposed.

McKeesport, Pa.—The McKeesport Construction Co. has been incorporated with $50,000 capital for the purpose of constructing streets and sewers in this city.

St. Louis, Mo.—The Board of Public Works has recommended a large amount of paving, principally Telford.

Bonds.—***New Decatur, Ala.***—The City Council contemplates issuing $35,000 of street improvement bonds.

Sherman, Tex.—The city has decided to issue $30,000 of public improvement bonds.

ELECTRICAL.

Electric Light.—New plants or extensions are proposed in the following places: Allegheny, Pa., address David Hunter; Brightwood, D. C., address J. E. Moses; Max Meadows, Va., address Land & Improvement Co.; Salem, Va., address the Mayor; South Charleston, W. Va., address the Improvement Co.; West Point, Ga., address the Planters' Oil & Mfg. Co.; Troy, Ala., address the Mayor; Ashville, Ala., address J. A. Hodges; Bartow, Fla., address J. W. Brady; Athens, Fla., address the Electric Light & Power Co.; Lake Forest, Ill.; Spencer, Iowa.

Attica, N. Y.—The Central Electric Light Co. has received a contract for incandescent 20 c. p. lamps at $15 each and 25 c. p. at $16.50. The company also offered 32 c. p. lamps at $18 each. Prices are for the year.

Washington, D. C.—Lieut. Francis R. Shunk, U. S. A. Engineers; Prof. H. A. Rowland, of Johns Hopkins University, and Andrew Rosewater, of Omaha, Neb., have been appointed a board of control of the district's electric wires.

Baltimore, Md.—The Westinghouse Electric Co. has received the municipal lighting contract which calls for 1,500 arc lights and 20,000 incandescent lamps.

Baton Rouge.—The Citizens' Electric Light Co. is said to have purchased the Baton Rouge plant for $30,000.

Griffin, Ga.—The Griffin Water Co. was recently incorporated with $75,000 capital stock by W. A. and J. T. Robinson and E. R. Hulbert, to erect an electric light plant and construct water-works.

Mounsville, O.—The State Legislature has granted the town permission to issue $20,000 of bonds for electric lighting purposes.

Arkadelphia, Ark.—C. W. Carder will receive bids for the construction of water-works and an electric light plant.

Electric Welding Machines.—The Thomson Electric Welding Co., of Boston, Mass., is putting in an electric machine to weld ¼-in. steel for wire and rods for the Cleveland (O.) Rolling Mill Co. Mr. Albert M. Bullard is superintending the work. A machine put in last April by this company for the Rogers Typograph Co. is reported to be giving excellent satisfaction.

CONTRACTING.

Sewers.—***Brooklyn, N. Y.***—The following bids for sewer construction were opened Oct. 24:

Bidder.	54-in. brick, per ft	48-in. brick, per ft.	42-in. brick, per ft.	36-in. brick, per ft.	30-in pipe, per ft.	18-in. pipe, per ft.	15-in. pipe, per ft.	12-in. pipe, per ft.	Manholes, each.	Catch basins, each.
	$	$	$	$	$	$	$	$	$	$
O. O'Keefe	7.50	6.00	5.50	4.50	3.50	1.90	1.60	1.25	35	100
H. Bogert	6.50	5.50	4.50	4.00	3.25	1.70	1.50	1.10	34	98
Harris & Maguire	6.11	5.70	4.89	3.90	3.31	2 00	1.77	1.46	36	100
D. J. Creem	6.00	5.00	4.50	4.00	3.50	1.85	1.65	1.25	35	100
J. Hickey	5.69	4.97	4.49	4.09	3.79	2.49	1.89	1 29	39	105
P. Milne	6.00	5.50	4.50	4.00	3.40	1.60	1.40	1.10	35	100
E. Gorman	5.75	5.00	4.75	4.00	3.25	1.65	1.50	1.00	35	97

Dredging.—***Cleveland, O.***—Major L. Cooper Overman recently opened a number of bids for dredging on Lake Erie. The total amount of the work is about 170,000 cu. yds. Caskin, Stickney & Cram, East Saginaw, Mich., offered to do the whole for 35 cts. per cu. yd.; J. A. Smith, Cleveland, bid $45,840, and J. Rooney, Toledo, $49,880 on all the work. Bids on small sections were at 22, 23, 25, 29, 30 and 32 cts. per cu. yd.

PROPOSALS OPEN.

Sewers.—***New York City.***—T. F. Gilroy. Nov. 6.
Brooklyn, N. Y.—J. P. Adams. Nov. 11.
Newark, N. J.—E. B. Gaddis. Nov. 6.
Rock Removal.—***New York City,*** T. F. Gilroy. Nov. 6.
Dredging.—***New York City.***—About 8,700 cu. yds. Dock Dept. Nov. 12.

Attention is called to the large number of government proposals for earth and rock dredging in our advertising columns.

Grading.—***Newark, N. J.***—L. E. Kane. Nov. 6.
Levee Work.—***Tallulah, La.***—About 550,000 cu. yds Levee Commissioners, Nov. 6.
Paving.—***Brooklyn, N. Y.***—Grading and paving with Belgian blocks. J. P. Adams, Oct. 20.
Water-Works Plant.—***Topeka, Kan.***—Attention is called to the advertisement in another part of the paper for materials for a complete water-works plant.
Mishawaka, Ind.—Pipe and castings for a complete gravity water-works plant. W. H. Dodge, Nov. 12.

MANUFACTURING AND TECHNICAL.

The Lake Erie Engineering Works, of Buffalo, N. Y., recently began the construction of what will be, when finished, one of the most complete plants in this country for manufacturing all kinds of engineering supplies, such as boilers, engines, etc. The plans provide for a machine shop built on the gallery plan. It will be 250 ft. wide × 112 ft. long, with a brick boiler-house at the corner, the engine being located inside the building. From the floor to the tracks of the traveling crane will be 40 ft. in the clear, and from the floor to the bottom of the iron truss will be 60 ft. in the clear. The foundry, which will be located in the rear of the machine shop, will be 230 ft. wide × 112 ft. long, the distance from the floor to the track of the traveling crane being 30 ft., and from the floor to the under side of the iron girders 45 ft.

Both buildings are to be erected on stone foundations set in cement, and consist of heavy brick walls, iron girders, and slate roof cemented on iron purlins. No wood will be used in the foundry building, and in the machine shop the only wood used will be for the floor and window frames. In the machine shop two 30-ton traveling cranes will be used and in the foundry two 30-ton and two 6-ton traveling cranes will be used, all being operated by electricity. The machine shop will be supplied with the heaviest machinery made and will be capable of turning out the heaviest work.

The machine shop is to be enclosed about Dec. 1, and the foundry about Jan. 1, both shops to be ready for business by April 1. About 500 hands will be given steady employment. The buildings will cost $110,000, exclusive of the ground, and with machinery complete will cost $300,000.

Mr. James Boland is doing the mason work. The Berlin Iron Bridge Co., of East Berlin, Conn., has been awarded the contract for the iron work. The officers are: President and General Manager, Richard Hammond; Superintendent, P. H. Kane.

The Brown Hoisting and Conveying Machine Co., of Cleveland, O., to meet the rapid growth of their business, is now doubling the capacity of their machine shop by erecting a new building 287 ft. long × 102 ft. wide, to be 36 ft. high in the clear. A new brick office and draughting building 43 × 77 ft., 3 stories high, is also to be erected. Among other work a 10-ton traveling crane is being constructed for the Newport News Shipbuilding Co., and two large cranes for the Illinois Steel Co., for unloading ore. They are also building an all iron coal storage building 674 ft. long × 354 ft. wide for Allbright & Co., Buffalo, N. Y., in which they will place 4 of their cranes, hung from trusses, capable of moving 2 tons of coal at a time. Business generally is reported good, several large orders for special machinery having been refused during the past year. With the increased capacity for production the company expects to be able to meet all future demands.

The Vulcan Iron Works, Chicago, Ill., have received orders for several highway bridges in Chicago and a railway bridge at Hastings, Minn., for the Chicago, Milwaukee & St. Paul Ry.

Iron Keg Machinery.—The Scranton, Pa., Supply & Machinery Co. wishes the address of parties manufacturing machinery used in making iron kegs.

Fire Hydrants.—W. S. Coon, representing the Bourbon Copper & Brass Works, of Cincinnati, O., has been awarded a contract for 90 Bourbon hydrants by the Upper Sandusky, O., Water Co. There was considerable competition to get the contract and the award was made only after a careful examination of the different claims.

Blackmer & Post, St. Louis, Mo., have begun work on a new 99 × 254-ft. 4-story factory to be used in the manufacture of double strength culvert pipe for railway and gravity water-works conduits. The new factory will have twice the capacity of the present plant.

The Ingersoll Milling Machine Co., of Cleveland, O., has recently completed two milling machines for the Illinois Steel Co., each 22 x 22 x 5 ft. The officers of this company are: President and General Manager, Winthrop Ingersoll; Secretary and Treasurer, R. H. Clark.

The Variety Iron Works, of Cleveland, O., has been awarded the contract for furnishing the material for the conduit for the new cable railway to be constructed on Broadway, New York City. They are also to furnish the 40-in. pipe for the new water supply tunnel now being constructed under the Cuyahoga River at Cleveland. A number of steel tanks are also being built by this firm for Malle & Co., of Mexico.

Car Couplers.—The Mark's Car Coupling Co., Cleveland, O., recently received an order for 50 of their couplers. O. L. Baker is Trustee of this company.

The Michigan Pipe Co., Bay City, Mich., have a contract for 10 miles of 10 to 4-in. Wyckoff pipe and 58 double discharge hydrants for East Aurora, N. Y., and a contract for 6 miles of pipe for Franklinville, N. Y.

Locomotives.—The Atchison, Topeka & Santa Fe R. R. has placed an order with the Brooks Locomotive Works for 50 locomotives. The Delaware & Hudson Canal Co. has ordered 15 mogul locomotives of the Dickson Mfg. Co. The Richmond Locomotive Works has obtained a contract for eight 8-wheel passenger engines for the Atlantic & North Carolina R. R.

Cars.—The East Tennessee, Virginia & Georgia Ry. has suffered considerably from the scarcity of rolling stock, and recently placed orders for 1,150 coal and 450 box cars.

New Companies.—South Atlantic & Gulf Harbor Improvement Co., Brunswick, Ga.; capital stock, $1,000,000; incorporators, C. Downing, M. Ullman, J. S. Thomas. Positive Screw Pump Co., Newark, N. J.; capital stock, $500,000; incorporators, C. C. Conner, H. C. Hauser, H. Volbrecht. Western Locomotive Co., Seattle, Wash.; capital stock, $2,500,000; incorporators, J. L. Ayer, J. Hadweiger, F. D. Burton. Tide Water Iron Works Co., Seattle, Wash.; incorporators, M. H. Burnfield, J. Hadweiger, L. M. McCurdy. Aluminum Plating Co., Newark, N. J.; capital stock, $100,000; incorporators, F. Emken, J. D. Darling, E. A. Riege. Chicago, Ill., Pneumatic Tube Co.; capital stock, $1,000,000; incorporators, G. W. Felton, H. C. Kelly, W. H. Fellows. Saginaw, Mich., Electric Co.; capital stock, $100,000. Rigby Safety Car Wheel Co., Detroit, Mich.; capital stock, $500,000. Port Huron & St. Clair River Railroad Co., Port Huron, Mich.; capital stock, $300,000.

Metal Market Prices.—***Rails.***—New York: $30; $26 for old iron rails. Chicago: $32 to $32.50; old rails, $26 for iron, $22 for steel. Pittsburg: $29.50; old rails, $28 for iron, $19 to $20 for steel.

Foundry Pig-iron.—Chicago: $15 to $17. Pittsburg $15.50 to $17.25. New York: $16 to $18.

Track Materials.—New York: steel angle bars, $1.80, spikes, $2; track bolts, 2.75 cts. with hexagon nuts, all New York delivery. Pittsburg: splice bars, 1.95 to 2.05 cts. for iron, 2 to 2.1 cts. for steel; spikes, 2.2 cts.; track bolts, 2.9 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 2.25 to 2.3 cts. for steel, and 2.1 to 2.2 cts. for iron; spikes, 2.3 to 2.35 cts; iron track bolts $3.10 to $3.15 with hexagon nuts.

Pipe.—Cast-iron, $27 to $30 per ton. Wrought iron, discounts as follows: 47½ and 40 per cent. on black and and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—Chicago, 5.35 to 5.45 cts. New York, 5.25 to 5.75 cts.

Structural Material.—Pittsburg: angles, 2.3 cts.; tees, 2.85 cts.; beams and channels, 3.1 cts.; sheared steel bridge plates, 2.65 to 2.7 cts.; universal mill plates, 2.35 cts.; refined bars, 1.9 to 1.95 cts.; steel plates, 4.25 to 4.75 cts. for fire box; 3.1 to 3.2 cts. for flange; 2.9 cts. for shell, 2.5 to 2.55 cts. for tank. New York: beams, 3.10 cts.; plates, 2.25 cts.; angles, 2.1 to 2.25 cts.; tees, 2.6 to 2.7 cts.; channels, 3.1 cts. Chicago: angle, 2.35 to 2.4 cts.; tees, 2.9 to 3.0 cts.; beams, 3.2 cts.; universal plates, 2.45 to 2.55 cts.; sheared plates, iron, 2.5 to 2.6 cts.; steel, 2.6 to 2.7 cts.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXIV. No. 45.

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OUR "NOTES FROM ABROAD," in the issues of Oct. 25 and Nov. 1 contain two typographical errors. The mixed gauge of the Great Western Ry. (England), referred to on page 375, is 7 ft. and 4 ft. 8½ ins., and not 7 ft. and 7 ft. 4½ ins., as stated. On page 399, 25th line from bottom, for "brake and lock" read "brake block," which is the English term for brake-shoe.

THE RAILWAY TRAFFIC RETURNS FOR BOSTON, Mass., according to the Massachusetts Railroad Commission in its last report, show an aggregate of 48,072,299 persons passing to and from Boston in the year ending June 30, 1890, an average of 131,700 for each of the 365 days. The Boston & Maine R. R carried 19,602,017 of this total, and the Old Colony came next with 12,543,944. The first named road operated 1,210 miles of track in three States, 472 miles being in Massachusetts. It transported a total of 29,613,549 passengers, an increase of 5.37 % over the year 1888-89. These passengers rode an average distance of 13.22 miles, and paid for passage $7,128,449 or an average of 24 cts. per passenger. The Old Colony R. R. has a total mileage of 563.55 miles, all but 6 miles in the State. This system carried 21,305,226 passengers, an increase of 7.14 % over 1888-89; the average haul per passenger was 11.7 miles, and the company was paid $4,541,061 for passage, or an average of 21.31 cts. per person. The Boston & Albany R. R. operated 388.73 miles (332.1 miles in Massachusetts), carried 11,002,597 passengers an average distance of 18.28 miles, and received in passage money $3,737,293, or about 34 cts. per passenger. The New York & New England R. R. operated 465.2 miles of road, and transported 7,637,290 passengers an average distance of 13.42 miles, and received $2,004,655 passage money, or 21.3 cts. per passenger.

THE BOYNTON BICYCLE system of operating railways is to be adopted by the Kansas City, Watkins & Gulf R. R. Co. on its new line from Lake Charles, to Alexandria, La., 105 miles, according to press despatches. The bicycle system will be operated in connection with the ordinary system. A locomotive and several cars will it is stated, be ordered soon.

AIR BRAKES AND SAFETY COUPLERS have been put on all the freight and coal cars of the Iowa division of the Illinois Central Ry., as provided for by the Coffin bill passed by the last Iowa Assembly.

CABLE STREET RAILWAYS are proposed in London, England. The Highways Committee of the London County Council has agreed to an application being made by the London Tramways Co. to the Board of Trade for authority to use cable power on the company's line already constructed between Kennington and Brixton, and on the authorized extension to Streatham Hill.

THE ESSEX ST. ELECTRIC STREET RAILWAY CO., of Boston, Mass., voted on Oct. 28 to issue $100,000 for the construction and equipment of the line.

AN EXPERIMENTAL ELECTRIC RAILWAY, 2,784 ft. long, working on the principle of sucking the car as a magnet through a coil tube in which the current is continuously caused to circulate just ahead of the car, has developed 25 to 30 miles per hour under somewhat unfavorable circumstances, and is regarded as of much promise. The coils are of No. 14 copper wire, 20 lbs. per coil, placed at intervals of about 6 ft., varying somewhat with the grades and curves. The car is 12 ft. long, 10 ins. in diameter, and weighs 350 lbs., carried on two bicycle wheels turning on ball bearings. A 20 HP. dynamo wound for a pressure of 1,000 volts furnishes the power. Prof. A. E. DOLBEAR is electrician of the company; 120 miles per hour is aimed at and seems to be promised. The cost of construction for an express and mail line is estimated at $15,000 per mile. The experimental track is at Cambridge, Mass.

TRAIN LIGHTING BY ELECTRICITY is contemplated by the managers of the Manhattan Elevated Ry., and estimates have been asked on 216 separate electric lighting outfits, or enough to equip nearly the whole number of trains in service. The *Electrical Engineer*, in a discussion of the matter, estimates that with 12 16 c. p. lamps per car, and provision for head lights, tail lights and cab lights, an engine and dynamo of 7 to 8 HP. will be required on each train. Our contemporary also suggests that as the stations need better light as well as the cars, it may be well to adopt some system in which the trains would take up their electric supply as they moved along the line.

A SEARCH-LIGHT FOR RAILWAY PURPOSES was tested on Nov. 1 by Mr. WHEELER, electrician of the New Jersey Central R. R. One Huntington light of 3,200 c. p. was mounted on the switch signal bridge 20 ft. above the track. As a result the bricks could be counted in a station building ¼ mile away; when turned on the track the ties could be counted to the same station. Colors were plainly distinguished at ½ mile distance. At 1,500 ft. it would enable an engineer to tell the position of switches. The reflector was shaped like those of locomotive headlights, silver-plated and highly burnished.

THE MOST SERIOUS ACCIDENT of the week occurred on Nov. 3, on a branch of the Delaware, Lackawanna & Western R. R. at Rock Cut, 4 miles south of Syracuse, N. Y. A coal train was standing on a siding to wait for the passing of an express train, which runs through without stopping at the rate of 40 miles per hour. Just as the express train came in sight the telegraph operator, who was sitting at the station, suddenly conceived the idea that the switch was set wrong, and he rushed out and turned it. Just as he realized his fatal mistake, the express dashed over the switch onto the side track and collided with the engine of the coal train. The engineers and firemen of both engines were killed, and several passengers and trainmen were injured. A serious accident from an unusual cause on the New York, Providence & Boston Ry. is fully described in another column.

A BRIDGE ACCIDENT on the International & Great Northern R. R. near New Braunfels, Tex., Nov. 5, by which two men were fatally injured, seems from the press accounts to have been a square fall. The train was a freight, and the first span went down with the engine and three cars.——On the Covington & Macon R. R. near Madison, Ga., on Nov. 1, a passenger coach at the rear of a mixed train left the track on a trestle and was precipitated 40 ft., injuring several passengers.——Near Bellaire, O., Nov. 3, six cars of a Baltimore & Ohio freight train, while passing over a temporary trestle which replaces a steel bridge washed out Oct. 13, were derailed and precipitated into the river.

THE JUSTIN DYNAMITE SHELL was again tried on Oct. 30 at Parryville. No dynamite was used, but the shell was filled with sand and capsules of wax; spermaceti, paraffine and camphor were placed in it. The former shells were made of cast steel, and found to be full of blow-holes, and these were charged with being the cause of the two previous failures, by igniting the dynamite by the heat of the powder gas. The shell used in the last experiment was forged steel, and was recovered unbroken. It was found that none of the capsules of the above-mentioned materials were melted, and Dr. JUSTIN believes that he has succeeded in preventing the entrance of the gas into the shell. He will in a few days test the merits of the new shell by firing dynamite.

ELECTRIC LIGHT FOR LIGHTSHIPS is now being considered by the United States Lighthouse Board. The new lightship at Sandy Hook will be so equipped if the proposed plan works satisfactorily. Experiments are now under way at the lighthouse station on Staten Island.

THE KRUPP CO., OF ESSEN, has issued a serial report on experimental gunnery, treating of howitzer practice, firing at high angles. The later experiments were made at Meppen with an 11.27-in. howitzer, 11.8 calibres long, and weighing about 11 tons. The gun, with its carriage, weighed 14 tons, and the bed on which it stood 45 tons. The projectiles used were armor-piercing shells of 512, 661 and 936 lbs., and steel armor-piercing shells of 661 lbs. The charges, from 40.7 lbs. of pebble powder to 57.3 lbs. of prismatic powder, "*C* 82." The horizontal armor deck target measured 52 × 15 ft., composed of four super-improved and riveted steel plates of a total thickness of 3¼ ins., backed by iron ribs and wood, and firmly supported about 5 ft. above the ground. The first shots were fired with an elevation of 45, and were 661-lb. shells, with a 25-lb. charge of pebble powder, and range of 3,870 yds., or nearly 2¼ miles. The greatest longitudinal deviation was 95 ft. and the greatest lateral deviation was 27 ft. The shell passed clear through the target at the second shot, bending the supports and tearing 10 rivets. In the second trial an elevation of 65° was used, with the same projectile and 33.8 lbs. of pebble powder. In 16 shots the greatest longitudinal deviation was 105 ft. and lateral 88 ft. One hit was made, penetrating the target as before.

THE IRISH CHANNEL TUNNEL scheme is again being agitated, and a meeting was held at Belfast, Ireland, in October, at which Mr. BARTON, C. E., submitted a proposition for a tunnel 33 miles long, between Magee, Id., County Antrim, on the Irish side, and a point in Wigtonshire, on the Scotch side. The greatest depth to be 500 ft. below the sea level, and the steepest grade to be 1 in 7 (5.33 per cent.)

NICARAGUA CANAL advices of Oct. 15 say that work has been commenced on dredging out the bar to the harbor and the first level of the canal. Five of the dredges used at Panama and now at the Nicaragua Canal are in a condition to go to work. The railway is steadily approaching completion, but progress is necessarily tedious as it passes through swamp land and all material must come from the east end. The timber in the swamp is cut, formed into rude cribs, and then filled with sand brought from the Greytown end.

THE MAKING OF ARTIFICIAL FUEL GAS is deeply interesting Pittsburg manufacturers. Among the companies mentioned as preparing for this change in fuel is the Pennsylvania Tube Works. Messrs. Swindell & Bros., makers of regenerative gas furnaces for making artificial fuel gas by the Siemens Anderson process, have considerable work in hand on new plant for mills. They say they can manufacture gas cheaper than it can be piped from wells.

The Serve Boiler Tube.

[FROM OUR LONDON CORRESPONDENT.]

A very simple device, which seems likely to do much toward increasing the efficiency of multi-tube boilers, has lately been introduced by a French engineer, M. SERVE. The invention consists simply in adding to the ordinary boiler tube a number of interior longitudinal ribs, generally about eight to each tube. The arrangement will be at once understood by the accompanying sectional view. The primary object is of course to get additional heating surface. This end is undoubtedly attained, for it is well known that the greatest resistance to the transmission of heat through metal is at the surfaces. Another advantage of these ribs is that they project into the interior of the column of heated gases and products of combustion flowing through the tube. This interior portion, or core of the column is always hotter than the sides. The gases have their temperature lowered by contact with the heating surface of the tube—which is naturally cooling surface for the gases—and it would seem that the colder particles have a tendency to stop on the outside of the column, so that much heat is carried to the smoke box which might more profitably have been absorbed by the metal of the tubes. There is a very good theory which accounts for this tendency of the colder gases to keep to the outside of the column. We need not stop to examine it now, but will proceed to give a few facts instead.

The manufacture of the Serve tube has been taken up in England by John Brown & Co., Limited, one of the great historic firms of Sheffield steel makers, in fact, one might almost say *the* great historic firm, for it was the ancient house of Brown that was the first among the big Sheffield steel makers to take up the manufacture of Bessemer steel. This firm, having, as they said, satisfied themselves as to the advantages of the Serve tube, determined to make a series of trials in order to prove to the engineering world at large that there is a benefit to be gained by the system. A number of engineers connected with the British and foreign governments, and others not holding official positions, were invited to attend the tests, and as I had also received an invitation to be present I am enabled to give some particulars of what took place. The arrangements for these trials were very complete, two large return tube boilers 10 ft. 6 ins. in diameter having been erected in the works. The following are the leading details of construction of these boilers:

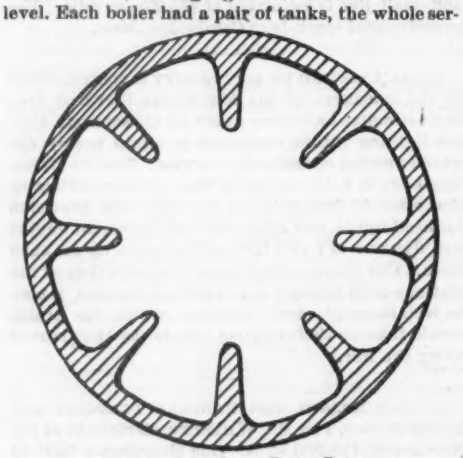
	No. 1. Serve tubes.	No. 2. Plain tubes.
Diameter of boilers	10 ft. 6 ins.	10 ft. 6 ins.
Length of boilers	10 " 6 "	10 " 6 "
Inside diameter of furnaces (two in each boiler)	2 ft. 10⅛ ins.	2 ft. 10⅛ ins.
Total number of tubes (steel)	136	136
Outside diameter of all tubes	3¼ ins.	3¼ ins.
Thickness of ordinary tubes	⅛ in.	⅛ in.
Number of stay tubes (steel)	34	34
Thickness of stay tubes	¼ in.	¼ in.
Length of furnaces of all tubes.	7 ft. 6⅛ ins.	7 ft. 6⅛ ins.
Heating surface of each ordinary tube	10.42 sq. ft.	5.95 sq. ft.
Heating surface of each stay tube	10.42 " "	5.45 " "
Total heating surface of tubes.	1,312.9 " "	732.7 " "
Area of grate surface	31 " "	31 " "
Heating surface of furnaces	135.5 " "	135.5 " "
Heating surface of combustion chamber	88 " "	88 " "
Total heating surface of boilers	1,536.4 " "	956.2 " "
Proportion of grate to heating surface	1 in 49.56	1 in 30.84
Total tube area for passage of gases	802.36 sq. ins.	852.18 sq. ins.
Section of fire bars	1 in. sq.	1 in. sq.
Distance between fire bars	½ in.	½ in.
Funnel, rectangular section	4 ft. × 2 ft.	4 ft. × 2 ft.
Height of funnel from top of combustion chamber	43 ft. 7 ins.	43 ft. 7 ins.

It will be seen by the above details that the boilers are similar in all respects except in the matter of tubes; and it was with this intention that they were made. The greater total of heating surface in the tubes is naturally due to the ribs, which are calculated as efficient for heating surface. It will be noticed that the stay tubes in No. 1 (Serve) boiler are of thinner metal than in No. 2 boiler. This is admissible, as the ribs give the necessary longitudinal strength for the purpose, a fact somewhat in favor of the taking up of heat by the water. Another point of difference between the boilers—and this is one unfavorable to No. 1—is the smaller area for the passage of the products of combustion between the combustion chamber and the uptake. The effect of this will be noticed when we come to the details of the tests.

The first trial was made on Tuesday, Oct. 21, commencing at 10 A. M. Nixon's Navigation—the best (Welsh) steam coal that Britain produces—was used throughout. The object of these tests was to show the superiority of the Serve tubes over plain tubes, both with forced draught and with natural draught.

I have used the term "forced" draught, but this I fear is a heresy, for "forced" draught is in evil repute with the general public ever since a certain gallant admiral styled it "an invention of the Evil One." Therefore "induced accelerated draught" was used in these tests; a fan being placed in each chimney. The water gauge fitted to the uptake immediately below the fans would show the amount of exhaustion, or vacuum, and this would naturally be a factor in the measurement of the quantity of air supplied to the furnace. The system of forcing draught by a fan in the chimney is by no means new. It was tried years ago in H. M. torpedo vessel *Vesuvius*, and failed. The failure, however, was due to defects in detail, which have been avoided in the present instance; but I fail to see why "induced accelerated draught" should be greatly superior to forced draught, excepting in convenience of application.

The water fed to the boilers was measured by means of four tanks. These were accurately made to give a like amount of water for similar degrees of fall in level; water gauges were fitted to show the level. Each boiler had a pair of tanks, the whole service being separate, so that there should be no question about "accidental" admission to the wrong boiler, as there so often is with the three-way cock system. Smoke box temperatures were taken with an azotic gas pyrometer; but I look on the readings obtained by this instrument as so questionable that I shall omit to give them.



Section of the Serve Boiler Tube.

The following is the observed data:

Three hours trial with induced accelerated draught at a pressure of 1⅛ ins. of water above that of the smoke box.

	Boiler No. 1. Serve tubes.	Boiler No. 2. Plain tubes.
Total coal burned	3,808 lbs.	4,144 lbs.
Water evaporated	32,500 lbs.	31,000 lbs.
Lbs. water per lb. coal.	8.53	7.48

Three hours with natural draught in both boilers.

	Boiler No. 1.	Boiler No. 2.
Total coal burned	1,810 lbs.	2,240 lbs.
Water evaporated	18,200 lbs.	20,100 lbs.
Lbs. water per lb. coal	10.05	9.00

It should be stated that the tanks were gauged to give gallons to the inch, but I have transferred the gallons into pound weight, as more in accordance with engineers' practice. This may, however, give the figures a roundness they would not otherwise possess, but the errors cannot be more than 10 lbs. in any one case. It was intended to generate steam at atmospheric pressure and to effect this the loads were taken off the safety valves. The opening, however, was insufficient, and a pressure of 10 lbs. and more was shown on the steam gauges. It is not likely, however, that this materially affected the results as a comparative test of the two boilers. The feed water was taken from the ordinary town supply and pumped in at normal temperature.

It will be seen that on the trial the first Serve tube shows a very decided and altogether remarkable superiority. The fuel economy is 14.07 per cent., due simply to the ribbed tubes.

There is, however, some price to pay for this. With the lessened area for passage of gases, additional draught is necessary to afford a given rate of combustion, and it might be that air enough would not not be supplied for economical working with natural draught. If so, the cost of fan and fan engine, steam and working expenses for the same should be taken into consideration. The additional cost of the Serve tube over the ordinary plain tube should also be borne in mind. It can hardly be supposed, however, that those items would balance so substantial a gain as 14 per cent.

Consider next the natural draught trials, which will serve partially to answer the first point just raised. I may state in passing that a three hours' trial is not nearly long enough to be conclusive; but having watched these trials through the greater part of their duration, I consider them sufficient to afford at least a very fair guide.

Here we have a gain of 11.6% in water evaporated per pound of coal without the adventitious aid of "induced accelerated draught." The steam user can, therefore, according to these figures, save about 12% of his coal bill if he use Nixon's Navigation coal and does not want to run more than three hours. This brings us to another feature of the system. Cleaning tubes is an important point in all boilers, but it becomes additionally important when a smoky or bituminous coal is used. The ribs in the tubes will certainly not tend toward facility in sweeping, but it is a difficulty that may easily be exaggerated. The ribs, after all, are radial to the axis and the wires of tube brushes also radiate from the same center. There would be no difficulty in removing dust and ash, but a bituminous coal burned with insufficient air or with too small a furnace and combustion chamber would doubtless leave a "fur" on the sides of the leaves or ribs that would be more difficult to remove than it would from the interior of a smooth tube. The obvious reply to this is that no one ought to burn any kind of coal, and especially bituminous coal, in small furnaces or without enough air, both for his own pocket's sake and the comfort of his neighbors.

On the second day of the experiments there was a 12 hours' trial with the two boilers with "induced accelerated draught" again, the excess of pressure of the atmosphere over that of the smoke box being from 1 to 1¼ ins. The test was so arranged as to burn exactly the same quantity of coal in both boilers in the 12 hours and the fans had to be manipulated in order to keep the consumption equal and so get through the given quantity by the time stated. As this is an important trial we will give the record in full:

BOILER NO. 1 (SERVE TUBES).

Hours.	Coal burned. Lbs.	Water evaporated. Lbs.	Vacuum at base of chimney. Ins.	Steam pressure. Lbs.	Temperature of feed. Degs.
1	1,568	9,000	1¼	10½	59
2	2,800	19,300	1	12½	66
3	3,808	27,000	1¼	15	60
4	4,928	39,800	1¾	11	61
5	5,824	49,600	1	10	60
6	6,832	59,300	1¼	11	60
7	7,504	68,600	1¼	10	60
8	8,400	77,200	1¼	10	60
9	9,520	87,300	1¼	11¼	60
10	10,416	96,000	1¼	10½	60
11	11,200	105,800	1⅜	10¼	60
12	11,872	114,600	1	10	60

BOILER NO. 2 (PLAIN TUBES).

Hours.	Coal burned. Lbs.	Water evaporated. Lbs.	Vacuum at base of chimney. Ins.	Steam pressure. Lbs.	Temperature of feed. Degs.
1	1,568	7,800	1½	9½	59
2	2,800	16,200	1½	8½	61
3	3,808	25,300	1½	9	61
4	4,928	34,400	1½	6	60
5	5,824	43,000	1½	6	61
6	6,832	52,300	1½	10	60
7	7,504	61,500	1½	6½	61
8	8,400	69,300	1½	6¼	60
9	9,520	78,500	1¾	8	60
10	10,416	87,500	1	6¾	60
11	11,200	95,100	1½	4½	61
12	11,872	103,000	1½	6¾	60

The equivalent evaporation from and at 212° would be about 11.19 lbs. of water per lb. of fuel and 10.05 lbs. of water per lb. of fuel for the two boilers respectively.

It was intended in this trial to evaporate at 212°, but although the safety valves were taken off, leaving two 3¼-in. openings, the steam could not escape without pressure accumulating.

It will be seen here that about 11¼% more water was evaporated by the boiler with the Serve tubes; a considerable falling off from the short run of the previous day with "induced accelerated draught."

(Why not call it "coaxed," or "encouraged draught' if "forced" is objectionable? "Induced accelerated" is too long). Even 11¼% is, however, a very remarkable saving—really an enormous saving in the present day, when we are apt to imagine we have almost arrived at finality in these matters, and are content to advance by ones and twos or even halves and quarters per cent.

I have little doubt as to the accuracy of the records. Engineers will understand that an individual visitor is unable to personally vouch for the details of boiler trials, even when made under his eyes with every facility afforded for observation. The wealth, position and high standing of the firm of John Brown & Co. are, however, a substantial guarantee that the tests were made with all fairness, and there were too many experienced observers present for any very big mistake to be made. The French Admiralty has made experiments of a very similar nature. A copy of the official report is now before me, but without going further into details, it is sufficient to say that the results above quoted are more than borne out.

Other trials were made at Sheffield, but at the time of writing the records have not been reduced to shape. Observation does not lead to the supposition that the details above given are not generally borne out. Should it prove otherwise, note will be taken of the fact in a future issue.

I have given a good deal of space to the record of a very simple invention, chiefly on account of the remarkable results obtained, but largely also from the fact that it is so simple. Practical engineers do not require to be told that simplicity is a cardinal virtue in all engineering practice. The Serve tube is so simple that one wonders it has not been introduced before, but we must remember that it is only the advance in metallurgy that has given us a cheap material, capable of producing these tubes at a cheap rate. The ribbed strips, or skelps, from which they are made could hardly be rolled in iron.

The Proposed Public Administration of the Water Supply of London.

The water supply of London is at present in the hands of a number of water companies, serving different districts of the city and suburbs. It is now proposed that the city authorities shall acquire the companies' property, and it is probable that a bill will be introduced into Parliament at its next session by which the necessary powers will be conferred on the authorities. The question is a very complex one, and there will be considerable trouble over the amounts to be paid for purchase. Some of the suburban districts, while approving of the proposal to bring the water supply under one public authority, protest against that authority being the London County Council alone.

The Corporation Committee for County Purposes have presented a report on this question, in which they state that they are of opinion that the legislation which will deal with the supply of water to the 5,500,000 inhabitants of the metropolitan area should be comprehensive and final. They feel that any attempt at piecemeal legislation would involve as much parliamentary trouble and opposition and consequent expense as the settlement of the whole question of supply. Sir WM. G. HUNTER, M. P., an expert on the water supply question, was president of the committee. The inquiry was commenced in May, and meetings were held in London, Manchester and Glasgow. The general conclusion of the committee is that the supply of water to the public should be in the hands of a public authority and no longer remain as at present under the control of private companies. This is the same conclusion as that arrived at by Sir WM. HARCOURT's Select Committee on London Water Supply in 1880, which reported that it was expedient that the supply of water to the metropolis should be placed under the control of some public body, which should represent the interests and command the confidence of the water consumers, and that a water authority of a representative character should be constituted with the necessary statutory powers.

The following abstract of the report presented in October last by the Committee for County Purposes is taken from the London *Daily Telegraph*:

Visits were paid to Manchester and to Glasgow, in each of which cities a public water authority prevails, and careful inquiry was made and evidence taken as to the working of the system. It is stated that in both cities the officials examined gave evidence showing the advantages and conveniences that had accrued to the consumers and to the cities themselves from the supply being in the hands of a public authority. As regards Glasgow, the comparison between its position when it emancipated itself from the private water companies and the present actual position of the metropolis is especially considered. Glasgow, up to 1855, was supplied with water by two companies (reduced by previous amalgamation from three), and in that year an act was passed authorizing their purchase by the magistrates of the city. The burden then placed upon the municipality appears to have been of a character both unexpected and oppressive. The works of the larger company were not usable, and had to be abandoned, an exceedingly large proportion of the purchase money being thus practically thrown away; but, with all this, the financial success has been thorough, and the comparative table of the quantity of water supplied and the prices charged in Glasgow and London respectively are in both instances largely in favor of the Scottish water consumer, who has supplied to his family considerably more water per head both for domestic and all other purposes, and (especially in the case of smaller tenements) pays considerably less for it. Evidence in this matter has been given by Sir ROBERT RAWLINSON, Maj.-Gen. SCOTT, and Mr. JAMES MORRIS GALE, the engineer of the Glasgow water-works. The average daily supply per head in Glasgow for domestic and all other purposes is 49.84 galls., while in London it is 29.91 galls. per head. The cost in Glasgow for a house of the annual value of $250 is, within the municipality, £1 9s. 2d. (about $7.25), and without the municipality, £2 1s. 8d. (about $10.41). These are the full amounts exacted, there being no extras in the shape of charges for bathrooms and other items, as is the case with every one of the London water companies. Comparing the metropolitan rates with the above, for a house of similar size in Lambeth (which it is only fair to state is from 40 to 75% dearer than any other metropolitan company) the water rate is £3 17s. about $19.18 more than two and a half times as much as in the city of Glasgow—and this, be it remembered, for a much inferior supply. On the same basis the Chelsea, Grand Junction, New River, and West Middlesex companies charge £2 4s. ($10.96), while Kent figures at £2 10s. ($12.50) and the East London and Southwark & Vauxhall companies at £2 14s. ($13.46).

Confirmed by such returns, and much kindred testimony, the Corporation Committee for County Purposes recommend that Parliament should be moved by the Corporation itself (for it is stated that at the present time no other public body has the power to incur the necessary expenditure) to legislate for "a representation of the areas, as the most effectual way of governing the watershed and managing the supply." They suggest the principle of arbitration as the fairest and best solution of the question of payment to the companies for their undertakings, and they claim to have it in evidence that the necessary moneys for the purpose of such acquisitions could be raised by the public water authority after its creation without any difficulty whatever. A sum of about $167,500,000 is hinted at as not an impossible one to be required for the purpose, and in his evidence Mr. SCOTT, the City Chamberlain, a financier of no small experience and sagacity, considers that no difficulty would arise in "placing" the stock on the best terms available on the day of issue, and not exceeding 3%.

On the somewhat delicate point of representation on the authority to be created, the committee take a large and liberal view; they think it should comprehend all the various municipal corporations, County Council, and sanitary authorities over whose areas the water authority would have control; that the city, considering the large proportion of its payments, should be adequately represented, and that the position of the Lon lon County Council should be "freely acknowledged and provided for." Suggestion is made that due compensation should be provided for directors and others retiring, and this being so it is not easy to see the reason that leads the committee further to recommend that a number of the directors of the bought-up and, therefore, defunct companies should be included in the new authority. Lastly, it is especially emphasized that the quinquennial assessment makes it imperatively necessary in the interests of consumers that some solution of the question should be arrived at in the next session of Parliament.

The Hall Process of Aluminum Production.

In our issues of Feb. 22 and March 1, 1890, was published the valuable paper by Messrs. A. E. HUNT, J. W. LANGLEY and CHAS. M. HALL on the properties of aluminum, and in that article a general description was given of the process of producing the metal in use by the Pittsburg Reduction Co. Since that time the company has greatly enlarged its plant, and its daily production of aluminum is now about 375 lbs. So much interest is felt in this metal, which promises to become of such importance in the arts, that we repeat the description of the process, with the accompanying cut, for which we are indebted to the *American Manufacturer*, showing the reducing pots in which the aluminum is extracted from the ore.

The crude material from which aluminum is at present obtained is bauxite, a hydrated oxide of alumina and iron. The mineral derives its name from being originally found in the vicinity of Baux, France. The bauxite at present used is imported from Germany, and costs about 5 cts. per lb. delivered at Pittsburg. This includes an import duty of $12.50 per ton besides the freight. Large deposits of the mineral exist in North Carolina and Georgia, and it is also found in vast quantities in Ireland and in northern France. Bauxite contains 55% to 58% of alumina, 10% to 14% of water, and 24% to 28% of silica and ferric oxide. As manufactured at Goldschmeidn, near Breslau, in Silesia, for the Pittsburg Reduction Co., the bauxite is fused with carbonate of soda in a reverberatory furnace. The fused mass is lixiviated with water, which dissolves the aluminate of soda, and this is decanted off. This solution is decomposed by carbonic acid gas, forming carbonate of soda, which remains in solution; and the alumina hydrate is precipitated as a white powder, containing about 54% of aluminum, in which form it is exported.

How hopeless would be attempts to treat bauxite by the ordinary methods of the furnace may be seen from the fact that it is so refractory that crucibles made from it remain unaffected when those of ordinary fire-clay lose shape and become partially fused.

The next process is the calcining of the alumina hydrate at a red heat, which drives off the water and leaves the alumina still in the form of a white powder ready for charging to the reducing pots.

As is well known, the metal is obtained from the alumina by the process of electrolysis, the alumina being held in solution in a molten bath composed of various fluoride salts, which conducts the electric current, but is not decomposed by it. The reducing pots in which the process is carried on are open rectangular boxes of wrought iron about 4 ft. long, lined with carbon inside, a small depression to admit the dipping ladle being left at the bottom of each. The negative conductor from the dynamo is electrically connected to the iron shell of the pot. The positive conductor is connected to a wrought iron frame placed just over the pot and supporting a number of carbon electrodes about 2 ins. in diameter. These are attached to copper rods, as seen in the drawing, which are held by clips, so that the carbon may be lowered into the bath as its lower end is gradually burned away by the oxygen of the alumina. About one pound of carbon is consumed per pound of aluminum produced. The pure aluminum as it is released from combination by the electric current falls to the bottom of the pot, being heavier than the fluoride bath, and is ladled out from time to time and cast into ingots, the molds for which are seen on the floor near the reducing pots.

The process goes on continuously, more alumina being thrown in the pot from time to time, new carbons taking the place of old ones as they are consumed, and the silvery, molten metal being ladled out at intervals when a considerable amount has collected. The heat radiated from the bath is quite moderate, and only when the workman ladles out the molten metal does he put on his mask, a curious looking rectangular shield which protects his face and eyes from the heat.

The cost of the materials for the fluoride bath is very small, and the bath does not deteriorate by use. A small quantity, perhaps 5 lbs. per week, is added to each pot to make up for the slight loss which occurs in ladling out the molten aluminum. The carbons used are 3 ins. in diameter and are made of compressed gas carbon. They cost about 3 cents per lb., 1 lb. of carbon being used to produce 1 lb. of aluminum. The ingots as cast from the reducing pots are remelted two or three times to purify them and secure a smooth solid ingot, fit for rolling. The slab, when ready for market is 6 ins. × 12 ins. × ¾ in. in size and contains above 98.52 % of metallic aluminum, the remainder being chiefly combined silicon.

The only part of the aluminum-producing plant which is especially expensive is that which generates the electricity required to decompose the aluminum oxide. The total energy required to dissociate one pound of alumina into its elements is given as equal to 35,640,000 ft. lbs. or 18 HP. acting for one hour. This, then, is the theoretical limit of economy

in producing aluminum by electrolysis. The Pittsburg Reduction Company are now producing about 375 lbs. of aluminum per day of 24 hours, with an expenditure of energy of about 500 indicated HP. Remembering the necessary losses between the steam in the cylinder and the electrical current delivered from the dynamo, it appears that the Company is now obtaining a pound of aluminum with the expenditure of less than 23 HP. of electric energy. Taking also into consideration the heat required to keep the fluoride bath fused with that lost by radiation and in the molten aluminum, and it is evident that the works are making a very commendable approach to the maximum possible economy in the use of power.

PRODUCING PLANT OF THE PITTSBURG REDUCTION CO.

The plant first erected by the company had a capacity of but 50 lbs. of aluminum per day. Power was furnished by a 125-HP. Westinghouse engine driving two 1,000-ampere 25-volt Westinghouse dynamos. The dynamos were run in parallel and supplied current to two reducing pots in series, each of which required 10 volts. The additional plant put in operation in the spring of the present year consists of two 200-HP. Westinghouse compound engines, additional boiler capacity of 624 HP., and two dynamos, specially designed for the company by the United States Electric Light Co., each furnishing a current of 2,500 amperes and 50 volts. These dynamos operate 5 reducing pots connected in series. The boilers are all fired by natural gas and are of sufficient capacity to permit of part of the plant being held in reserve. Each of the compound engines is belted direct to one of the large dynamos, and the 5,000-ampere current from the two is carried to the reducing pots by two copper bars, each having a cross-section of 3 sq. ins. The 2,000-ampere current from the two small dynamos is carried to the reducing pots by a copper bar of 2 sq. ins. cross-section.

Over the engines and dynamos is a 6-ton traveling crane for use in removing armatures or making repairs; the necessity for this is apparent when it is remembered that each of the larger dynamos weighs 24 tons. The labor required in operating the plant is quite small. An engineer and one assistant look after engines, dynamos and boilers; one or two men are in charge of the reducing pots, one is engaged in remelting, and there are one or two laborers. With an enlarged plant the cost of labor per pound of product will be considerably decreased. So large is the present demand for aluminum and so promising are the prospects of a large increase in the demand in the near future, that plans have already been completed for a plant which will produce 5 tons of aluminum per day, requiring for that purpose about 13,000 HP. Of course the best point to establish such a plant will be where power can be obtained most cheaply, and by choosing a site either where ample water power can be had or near the mouth of some coal mine it is expected to largely reduce the present cost of manufacture.

A plant has just been put in operation at Patricroft, near Manchester, England, to make aluminum under the Pittsburg Reduction Company's patents, which it is expected will go far toward supplying the foreign demand, for the present at least.

Among recent discoveries in connection with the application of aluminum in the arts is the fact that a tempered pure aluminum can be produced which will take a cutting edge and is considerably stronger, harder and more elastic than the untempered article. Processes of plating with aluminum are also being perfected, both by use of the electric current and by dipping as in galvanizing. It is claimed further that in making nickel steel, which has recently been brought into such notoriety, the addition of a small amount of aluminum increases the homogeneity of the alloy.

In another column some estimates will be found concerning the probable cost of producing aluminum by this process when the maximum possible economies shall have been effected.

The Porro Telescope for Stadia Work.

By J. B. Johnson, Prof. Civ. Eng., Washington University, St. Louis.

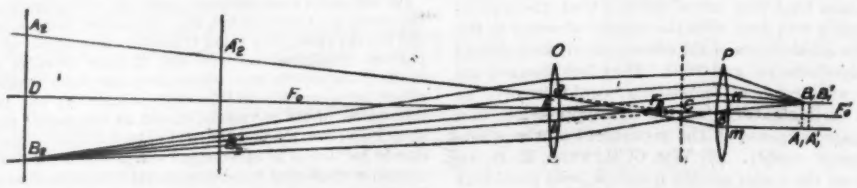
The objection which is most frequently urged against the use of the stadia method by those who are familiar with its theoretical principles only is that the distances read on the rod are not the true distances from the center of the instrument, but from a point in front of the objective equal to its focal length. It is true the rod may be so graduated as to give the true distance from the center of the instrument for any particular length of sight, but for other distances the reading is either too large or too small by an amount less than 1.5 feet in the most extreme cases.

Although these objections are of little force in practice, since such small distances do not show on the plat, still it is very desirable to avoid such errors, for one's mental satisfaction, if for nothing else. If these errors could be avoided it is probable that many engineers and surveyers would use the stadia who now refuse to resort to it even in rough work.

It is not generally known that this error may be avoided by changing the construction of the telescope, but such is the fact.

In 1823 Mr. Porro, a Piedmontese officer, and afterwards a professor at Milan, invented a telescope which accomplishes this result, and in such a way as not to interfere with its use for all other purposes in transit work. It is done by the aid of an auxiliary lens placed back of the objective, which latter is now of a lower refracting power.

In the figure, let the lines $A_2\ a\ C$ and $B_2\ b\ C$ be the lines which limit the measuring angle and which meet at C, the center of the instrument. That is to say, these lines are such that a pencil of rays starting from any point on the line $A_2\ a$ is brought to a focus upon the cross-wire at A_1, and any pencil of rays starting from a point on the line $B_2\ b$ is brought to a focus on the cross-wire B_1, these lines $A_2\ a$ and $B_2\ b$ meeting, if extended straight through the objective O, at the center of the instrument, C. But in passing through the objective these rays are refracted so as to meet at some point as F_p, and if this point is also made the principal focal point of the auxiliary lens P, then those particular rays pass out of the lens P on the *parallel* lines $m\ A_1$ and $n\ B_1$.



For a rod placed at $A_2\ B_2$ the image is formed at $A_1\ B_1$, the image of A_2 being at A_1, and of B_2 at B_1. If now the rod be moved to the position $A'_2\ B'_2$, the image will move to $A'_1\ B'_1$; but since the rays entering the objective along the lines $A_2\ a$ and $B_2\ b$ emerge from the auxiliary lens along the *parallel* lines $m\ A_1$ and $n\ B_1$, it follows that the *images* of any two corresponding points on the lines $A_2\ a$ and $B_2\ b$ remain at a *constant distance apart*, and, therefore, if cross-wires be placed at these points the refocusing for varying distances does not prevent the wires from measuring an interval which *varies directly with its distance from the center of the instrument.*

It will be seen that the points Fp and C are conjugate foci on the same side of the lens O, the distance $E\ C$ being the distance from the center of objective to center of instrument commonly denoted by C. The principal focus of O in front is at some point as Fo, and the principal focus of P is at Fp.

Then we may have:

Focal length of O, $F_o\ E = f$.
" " " P, $F_p\ G = f'$.

The conjugate focal distances, $\begin{cases} E\ F_p = f_1. \\ E\ C = (-c). \end{cases}$

The distance $D\ C = D$.

Then for the lens O we have, from the general equation of conjugate focal distances:

$$\frac{1}{f_1} + \frac{1}{(-c)} = \frac{1}{f} \quad \text{or} \quad f_1 = \frac{f\,c}{f + c} \tag{2}$$

and

$$\frac{f_1}{c} = \frac{f}{f + c} \tag{3}$$

Now let the angle $a\ C\ b = C$ and the angle $a\ F\ b = F$, and since these are very small we may suppose them proportional to their tangents, whence

Ang. F : ang. C : : c : f_1 : : $f + c$: f,

$$\text{or ang. } F = \frac{f + c}{f} \text{ ang. } C \tag{4}$$

But tan. $C = \dfrac{A_2\ B_2}{D}$ and tan. $F = \dfrac{m\ n}{F_p\ G} = \dfrac{A_1\ B_1}{f'}$

therefore we have

$$\frac{A_1\ B_1}{f'} = \frac{f + c}{f} \cdot \frac{A_2\ B_2}{D}, \text{ or}$$

$$A_1\ B_1 = f' \left(\frac{f + c}{f}\right) \frac{A_2\ B_2}{D} \tag{5}$$

This equation gives the distance between cross-wires for a given ratio of intercepted portion on rod to distance from the center of the instrument. If this ratio be taken as $\frac{1}{100}$, which is commonly chosen, then we have, for the distances between cross-wires:

$$A_1\ B_1 = \frac{f}{f} \cdot \frac{f + c}{100} \tag{6}$$

The distance f is the focal length of the objective, which may be obtained approximately by removing it from the telescope and obtaining an image of the sun. The distance $\dfrac{c}{R}$ is readily measured on the telescope, it being the distance from the vertica

axis of the instrument to the center of the objective.

The focal length of the auxiliary lens f' must also be found independently, as with the objective, but these lenses must be chosen with reference to the length of the telescope desired.

Thus the distance from the objective to the cross-wires is made up of the distance between the lenses O and P, which is $f_1 + f'$, and the distance between P and the cross-wires. This latter distance varies for different positions of the object, being $f - \frac{f^2}{f^2}(f + c)$ for a stellar focus and f' for the object placed at the distance f in front of the objective.

Therefore, we have, for the distance between the objective and the cross-wires, for a stellar focus:

$$L = f_1 + 2f' - \frac{f'^2}{f^2}(f + c)$$
$$= \frac{fc}{f+c} + 2f' - \frac{f'^2}{f^2}(f + c) \qquad (7)$$

and for the nearest position of object, say 1 ft. in front of the objective,

$$L = \frac{fc}{f+c} + 2f' \qquad (8)$$

where

L = distance between objective and cross-wires.
f = focal length of objective.
f' = focal length of auxiliary lens.

If we make $f = 15$ in., $f' = 4$ in., and $c = 6$ in.,

then the extreme distance between objective and cross-wires, for an object about 1 ft. in front of the objective, is from (8), 12¼ in., and the minimum distance, or the distance for a stellar focus, is from (7), 10¾ in.

If $f = 14$ in., $f' = 3\frac{1}{2}$ in., and $c = 6$ in.,

then the extreme distance between objective and cross-wires is 11.2 in., and the least distance is 10 in.

For this latter case, the auxiliary lens being placed $f_1 + f'$ back of the objective, we have from (2)

$$f_1 = \frac{fc}{f+c} = \frac{6 \times 14}{6 + 14} = 4.2 \text{ in.}$$

Whence the distance between these lenses is 4.2 + 3.5 = 7.7 in., or 1.7 in. back of the center of the instrument.

These two lenses, O and P, must remain at a fixed distance apart, and hence must be mounted in the same tube, and if the objective slides they must move together.

A very notable result of this combination are the small movements required in focusing on objects at varying distances, and the ability it gives one to read upon objects within about 1 ft. (the focal length of the objective) of the object glass. Thus the movement of the cross-wires (or objective), in the second case worked out, was only 1.2 ins. from a stellar focus up to a position of object 14 ins. in front of the objective. It would probably be a profitable venture for some of our best instrument makers to go to manufacturing these telescopes for their transit instruments. They should always be made to invert the image and so avoid the use of the two erecting lenses. In this way a better definition is obtained, and a lower refracting power can be used in the objective and auxiliary lenses for the same length of telescope.

THE PANAMA CANAL is actually a thing of the past, and nature in her works will soon obliterate all traces of French energy and money expended on the Isthmus. Reports of Oct. 25 say that the late heavy rains have caused vast slides into the canal from the hill tops near Obispo, and the canal excavation at Circaracha is entirely filled up. Only one dredge of the American Company now remains at Colon, the *Nathan Appleton*. The dredge *Ferdinand Lesseps*, of the same company, was sunk about 60 miles from Colon, while being towed to Greytown. Lieut. N. B. WYSE, acting for the Panama Company, writes from Bogota, under date of Oct. 20, that owing to the exacting terms sought to be imposed by the Senate Committee, "it appears that it will be impossible to reach an understanding."

Subaqueous Foundations.*

LECTURE I.—INSIDE WORKS.

During the last thirty years marked progress has been made in what may be termed the department of engineering science which deals with foundations of structures laid down under water. New methods of executing work, new appliances and new materials of construction have enabled the engineer to successfully execute works which, a comparatively short time ago, would have been either quite impossible, or prohibitory on account of cost.

In the two lectures I am about to deliver I will endeavor to place before you the most recent practice in subaqueous foundations, illustrated by representative examples of work executed. I will also refer to the ordinary methods of timber piling and coffer-dams, which are so valuable in numerous cases for works of moderate extent, or where exceptional difficulties do not present themselves.

In cases where a depth of only a few feet of water has to be excluded, no limitations imposed in regard to space occupied and the foundation composed of sandy or clayey material, then an earth dam formed entirely of clay, or having a central wall of clay, is the simplest and most effective method of excluding the water for the site of the works, and, as regards maintenance, is the least troublesome, care, of course, being exercised to see that a complete clearance be made along the site of the proposed dam of all stones, gravel, shingle, sand or other materials which would allow water to pass freely. In a semi porous stratum a trench should, if possible, be excavated or dredged down to an impervious stratum, or to such a depth that there would be no danger of percolation of water through the strata underneath the dam, which depth would be dependent on the nature of the strata, and the head of water against the dam. A very thin wall of puddled clay, say from 12 ins. to 18 ins. in thickness in the center of an earth embankment, is quite sufficient to serve as a water-tight wall, provided that care be taken that the clay is of good quality, free from stones or other extraneous substances, and has been thoroughly chopped and well worked before being placed in the dam, in successive layers, each layer being rammed or punned in place, so as to leave no horizontal lines or joints of separation. In practice, however, it is better to carry up a much thicker wall of clay, so as to provide a good margin of safety against the risks of defective workmanship, and the use of inferior materials. The places where leakages are most likely to occur in such dams, or, indeed, in dams of any kind, are their ends, or junctions, with smooth surfaces, such as the faces of quay walls, paved slopes, embankments, etc., and special precautions should be taken at such places by forming gusset dams, grooves, if possible, in the walls, or by increasing the thickness of the puddle clay, and also by exercising great care with the punning and hard stock ramming of the clay. I might quote a number of instances from my practice of the importance of such precautions, but one may suffice, which occurred at the eastern entrance of the James Watt Dock at Greenock. An earth dam was there formed to exclude a head of water of about 14 ft. At one end of the dam, which abutted against the paved slope of an embankment, sufficient care was not exercised by the contractor in making a proper junction of the dam with the paved slope; the result was a heavy leak, which undermined the paved slope, involved a heavy outlay to stop it, and also caused a serious delay in the general progress of the works. An earth dam, with its slopes, occupies a considerable area of ground, and is seldom used, except in cases where there is ample room. When the area for operations is limited, there may be used a single pile dam, backed up with clay on the outside, and walled and strutted on the inside.

In the construction of quay walls, where half-tide dams are sometimes employed, that is, dams constructed to such a level as to exclude the tidal waters, from half-ebb to half-flood, single pile dams are most serviceable. I have used them in a number of instances, the most recent being in the harbor of St. Helier, Jersey, last year in the execution of some harbor improvements there. In the southwest angle of the Victoria Harbor, St. Helier, a new landing stage was constructed, the quay, or front wall, of which was founded on the rock, at depths varying from 12 ft. to 22 ft. below the surface of the bottom of the harbor. The back, or light division walls, of about 25 ft. in height below coping, along the side of the inclined railway, down to the middle and lower landings, were founded on bearing piles from 24 ft. to 30 ft. in length, driven down to the rock, or to depths of from 47 ft. to 53 ft. below high-water level, and although the capsills, longitudinal and cross bearers, and bruised points of piles on the rock were subjected to this great weight of wall and filling, they have not squeezed down, or subsided more than at the rate of about 1-32d in. per foot in height from quay level to the rock, which is not nearly so much as usually takes place under similar conditions, while the face wall, which is founded on the rock, shows, as a matter of course, not the slightest sign of subsidence or movement of any kind for its whole length. By founding the division walls on bearers and bearing piles, instead of on the solid rock, a saving of several thousands of pounds was effected. To enable the front wall to be founded on the rock, I had a back and front row of 6-in. pitch pine close sheeting piles driven at about 16 ft. apart and parallel with the back and front faces of the proposed quay wall. These piles were driven to the rock, or as far down as 25-cwt. monkeys would drive them. The tops of these sheeting piles were cut off at a few feet below half-tide level, and clayey material was embanked against their outside faces. The material driven through was composed of fine compact sand and clay. The range of spring tides is nearly 40 ft. and the depth from high water to the rock in the bototm of the trenches was in some places as much as 53 ft. or 33 ft. below half tide. The rock for the full length of the wall foundations in the trench was successfully laid bare, and the wall founded thereon, at depths varying from 47 ft. to 53 ft. below high water of spring tides. The trench was cleared in lengths, equal in capacity to about 900 tons of water on an average, which took about 42 minutes to pump out by a 16-in centrifugal pump, mounted on a barge. At one end of the trench the new works abutted against an old quay wall of the Victoria pier, founded on loose stones and sand at about 12 ft. above the bottom of the new work, and the foundations of the old work had to be protected by pole boarding below the feet of the sheeting piles of the trench. Some trouble was here experienced, in several instances from "blows" through the fine sand at open joints in the sheeting piles, and under the piles, but the "blows" were promptly dealt with as they arose. Had prompt attention not been paid to these "blows" the dam would have soon collapsed, as the removal of the sand from the back of the dam would have so slackened everything as to have rendered the sheeting piles, struts, and walings free to float or rise up, as soon as the incoming tide had filled the dam.

Stock ramming, often found serviceable in tightening leaky coffer dams, was used at this work in filling up a large cavity under the wall, and also in stopping a heavy "blow" from under the foot of a broken pile which had not stood driving down to the rock. I may here give you a short description of what is known as stock ramming. During my practice I have frequently had to deal with most serious leaks, under and through coffer-dams, foundations, dock sills, dock sides, and dock bottoms. These leaks, subjected to constant heads of water, had they not been immediately dealt with, would in a very short time have brought about the entire failure of the works. In such cases any attempts to have stopped the leaks by grouting up with Portland cement would have been futile, for as soon as the grout poured down the pipes had reached the leaks it would have been washed away. Grouting up with Portland cement can only be done successfully when it is possible to equalize the head of water, so as to prevent any disturbance of the grout until it has thoroughly set, and is capable of resisting water pressure. Sometimes leaks are gauged, that is to say, only so much water escapes as can pass through the interstices of a bank of rubble, rough ballast, fissures, or open joints in masonry, or in sheeting piles, or through hollow beds between the underside of a foundation course of masonry and the surface of a rocky foundation. Such leaks are not immediately dangerous, for as soon as the puddled clay in the rear of these leaks is washed away the velocity of the leakage water, owing to the enlarged orifices in the puddled clay, is so reduced as to pass almost harmlessly away. But leaks which are not so gauged, that is to say, those which pass through the puddle and retain their full force due to a constant head of water, irrespective of the size of the orifices, and acting directly and freely on the puddle, soon create a great "blow," and effect a speedy destruction of the dam. For tightening up dams, dock bottoms, etc., I have used a stock-rammer as per sketch (Fig. 1). It is about 3 ins. in diameter, 3½ ft. in length, and has its head and foot rung with iron. A ¾-in. air-hole is bored up from its foot for about 20 ins. or 30 ins., and this is covered by a thick shoe-leather flap, which serves as a valve to admit air and prevent suction during withdrawal.

FIG. 1.

In stock-ramming a coffer dam, 3¼-in. holes are first bored in the piles, then charges of clay in rolls of about 3 ins. in diameter and of from 6 ins. to 9 ins. in length are inserted into them. The stock-rammer is then driven by heavy mauls into the hole as far as its length will admit is afterwards withdrawn and other charges of clay inserted, and so the process is repeated until it is found impossible to drive in more clay. The action is similar to that of a Bramah press, and by this means heavy leak

* By Walter Robert Kinipple, M. Inst., C. E. Lecture delivered before the Royal Engineers' Institute at Chatham. From the London *Engineering*.

in dams have been readily and successfully stopped in a very short time. A coffer-dam across the entrance channelway to the graving dock at Greenock, erected in the year 1871, was so badly filled with inferior puddled clay that, on testing it, it leaked to such an extent as to threaten its destruction within a few days. Stock-ramming, as above mentioned, was resorted to, and in a week or so it was rendered absolutely water-tight, although there was a head of water against it of about 15 ft. each tide during the process of stock-ramming and tightening up. A wooden plug was inserted in each hole, and was removed from time to time as further clay was found necessary. In earth or puddled clay dams of great width at base, across valleys, it is necessary for stock-ramming purposes to put down bore-holes as near as possible to the sites of the leaks and of from 3 ins. to 5 ins. in diameter, and line the same with wrought-iron tubing. Charges of well-puddled stiff clay are then dropped into the pipes, and rammers of wrought-iron round bars nearly filling the pipe, and having air-holes and flap as in the smaller rammer, are lifted up by a small pile-driving engine, worked by steam or hand, and dropped from a height of 10 ft. to 15 ft. down the tube, as the case may require. In this manner the puddle clay can be inserted and rammed hard into any of the cavities or leaks in the bore-hole, and

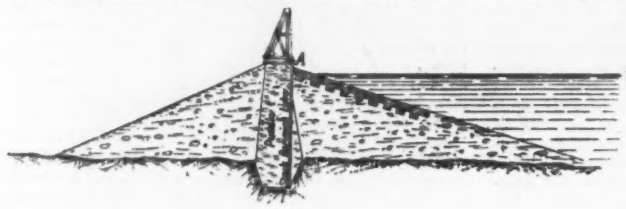


FIG. 2.

the softened and wasting clay may be hardened and tightened up to such an extent as to effectually and securely stop any leak in the dam. In fact, hard ramming may be carried on to such an extent as to almost lift a dam of 100 ft. in height. The positions of the bore-holes for stock-ramming such dams would depend upon the section and construction of the work, but generally the most suitable positions would be as shown in Fig. 2.

Single pile dams may be utilized for excluding a very considerable head of water, if sufficient care be exercised in so driving the piles as to insure close joints, and additional precaution be taken of grooving the piles and inserting iron or hard wood tongues. Very successful and well executed work of this class was done in connection with the founding, at 47½ ft. below T. H. W., the four piers and two abutments of the new Putney Bridge over the Thames. The piles were 14 ins. square, having elm tongues, and were driven through mud and clay down to the stiff hard clay, and formed almost perfectly water-tight dams. After the dams were completed, the pier foundation caissons were sunk inside the dams to a lower level, and rapid progress was afterward made with the excavations and the founding and building of the piers within the dams. The use of a single pile dam, which occupies a minimum amount of space, is an important consideration, especially when the area is limited. It is essential, however, that very careful work should be done, especially where there is a great head of water against the dam. Where the conditions are such, either from the inexperience of workmen or from the nature of materials through which the piles have to be driven, that it is impossible to make close work, recourse should be had to a double pile dam inclosing a wall of puddled clay; such dams being used for heads of water up to 40 ft., and in sites where it is impracticable to obtain close jointed piling. The dimensions of the timbering and ironwork are, of course, dependent upon the head of water, and likewise on the conditions of each particular case. In a dam of about 500 ft. in length, which I designed for the Esquimalt Graving Dock Works, Victoria, British Columbia, there were three rows of close piling, the depth of water in the center of the dam being nearly 35 ft. at high water, gradually diminishing towards its ends. Along the site of the dam there was a layer of sand and shells, several feet in thickness, everlaying a bed of clay in the center portion of the dam and rock at each end of it. The sheeting or close piles of the dam were of 12-in. by 12-in. fir timber, the gauge piles 15-in. by 15-in., also of fir timber, as well as the wales, which were 12-in. by 12-in. The thickness of the puddle between the piles was 7 ft. At the ends where the dams rested on the rock, special precautions were taken by means of heavy rock shoes on the piles, and by depositing concrete along the feet of the piles to render the dam secure. The dam was thoroughly water-tight from its completion in October, 1879, until the spring of 1887, or just prior to the opening of the dock.

Wherever it is possible in the execution of the subaqueous portions of the works to exclude the water from the area of the works by such simple means as dams, and where there is no objection in regard to space occupied, then undoubtedly such a course should be adopted. The facilities for executing such temporary works are usually at hand, and above all it is most advantageous and economical to carry on the main works within an area laid dry, where work can be executed with rapidity and in the best possible manner, instead of under water, where, even when perfectly satisfactory results are believed to have been obtained, they are generally under disadvantageous conditions. There are many cases, however, where, owing to considerable depths of mud or soft strata, it would be quite impracticable to exclude the water by means of dams, and recourse must then be had to other methods of founding, such as sinking by means of caissons down to a firm stratum, or of driving bearing piles down to the same, or the foundations may be spread out so as to increase the bearing area (Fig. 3).

Founding on the tops of bearing piles is a very old practice. It is still used to a considerable extent, but not so much as formerly. The general practice is to drive over the area of the foundation piles from 9 ins. to 14 ins. square, and centered from 3 ft. to 4 ft. apart. On the tops of these piles whole timber bearers are laid longitudinally and transversely, and covered with planking, the whole being well bolted together, and the masonry structure built thereon. Timber, when thus completely buried, is preserved for a very long period. I have here a specimen taken from one of the bearing piles of the foundation of the old Stockwell Bridge, Glasgow, a structure built in the year 1345, by Bishop Rae, in the reign of King David, son of Robert the Bruce, taken down in the year 1850, and replaced by the present bridge. The oak timber in the piles and bearers when taken up was as sound as when first laid down. A quantity of the timber taken from these foundations has been converted into tables, cabinets, picture frames, etc., and no appearance of shrinking or drying up has been visible, which is remarkable after having been buried for so long a time. I might give another instance of the durability of timber where so buried. In 1869 the bottom of the King and Queen Dry Dock, Rotherhithe, was reconstructed, when it was found that the old dock bottom groundways of English elm, which were taken up, were in such a good state of preservation that I had some of the ribs of the new gates to the dock made from them. Dock walls almost innumerable exist founded on piles, especially in Holland, where they have been used to a very large extent. In founding on piles the piers of bridges crossing rivers, precautions must be taken to guard against the risk of any scouring action set up by tidal or other currents removing a portion of the bed of the river next to the piers, thus leaving the piles exposed for a portion of their height, and which, if not protected, would soon result in the failure of the bridge. Many subsidences of the piers of bridges have been brought about through this cause; for instance, the old Westminster and Blackfriars bridges across the Thames, and recently, to guard against such risks, the foundations of Waterloo Bridge have been protected and strengthened, ordinary coffer-dams having been used for excluding the water, so that the protection of works of underpinning and concreting around the bases of the piers could be executed dry. Precautions against scouring action may also be taken by surrounding the bases of the piers with concrete deposited *in situ*, or by rubble stones of sufficient sizes to resist the strongest currents, or by depositing the same in the form of rough rubble paving between the piers of the bridge, and for some distance above and below the cutwaters. The last-named method, however, is highly objectional in a navigable river, especially if there is only sufficient depth of water for large vessels to pass at the top of the tide. A better course to pursue is to carry the solid foundations down to a firm stratum, or to such depths that no danger need be apprehended from scour. In some instances, where great depths of soft strata exist, and where very long piles had to be used, it has been necessary to "fish" them, as shown in Fig. 4, in order to obtain the necessary length; thus, at the Prince's Pier, Greenock, a section of which is given in Fig. 5, there is a considerable depth of very soft strata, as much as 90 ft. in places, below the bed of the river, overlaying the firm clay. An ordinary masonry or concrete quay wall on such a site as this would have been almost impracticable, and a timber structure was therefore adopted, consisting of piles 16 ins. square driven down into the firm clay. Many of the piles were upward of 90 ft. in length, each formed of two logs fished and jointed together during the process of driving. So soft was the material overlying the hard clay that the piles by their own weight sank several feet into it before a blow was struck by the monkey. The upper portion of these piles were of greenheart timber from 40 ft. to 50 ft. in length, and their lower portions of pitch pine. In driving to such depths considerable difficulties were encountered, but these were gradually overcome as the men gained experience. The quay is 20 ft. in width at top, and the piles are spaced 10 ft. apart transversely and 8 ft. longitudinally. At about 2 ft. and 15 ft. down from the top of the piles heavy ties are secured to the back piles of the pier and carried back for a distance of 100 ft. to the back-tie piles, used for tying back the quay. The filling behind the quay was retained by sheeting piles and back planking. Subsidences of the backing of clay, which was the material first used for filling, took place to such an extent as not only to cause the piles to bend forward, as shown (Fig. 5), but the bed of the river in front of the quay to rise several feet. As the heavy material deposited behind the piles was gradually filled in, so the mud in front of the quay continued to rise higher and higher, when, owing to the heavy pressure caused by the backing of clay, the piles became so bulged at about 30 ft. down from cope as to subject the lower ties to such a heavy strain that they ultimately gave way; while the top ties, by the falling back of the heads of the piles became slackened. At this juncture, in January, 1869, I was consulted by the Greenock Harbor Trust, and the measures I then adopted to prevent further movement of the structure were to dredge a trench 24 ft. in width by 8 ft. in depth, and 1,000 ft. in length, along the front of the quay, below the bottom where the bed of the river was soft, and to fill it up with whinstone rubble, which had the effect of at once arresting the outward movement of the quay and of practically taking off the strain from the whole of the ties. This was so marked that it became quite an easy matter to straighten the line of quay by adopting a few further precautionary measures, such as backing up behind the quay with cinder ashes, depositing extra rubble under and in front of the quay, and also by utilizing the bumping of steamers against the quay at the places where it had bulged the most, the ties having been previously very tightly screwed up, and men told off to give an extra screw up just as the steamers bumped. Additional ties were carried back to nearly 250 ft., from the front of the quay, stone being deposited in front of the tie piles and cinder ashes behind them.

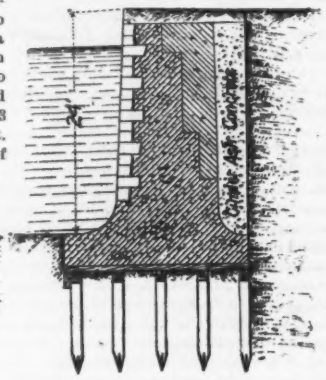


FIG. 3.

Fig. 4.

Since the introduction of Portland cement as a building material, it has been used to a considerable extent in the construction of subaqueous foundations. Many devices have been adopted to secure, by means of Portland cement concrete, substantial and reliable work under water, sometimes with the aid of divers and sometimes without, or almost so. In many instances the proportion of materials, and the manner of placing them in the work, have been such that sound work could not possibly be executed. Too frequently the fact has been overlooked that, owing to the particles of the cement being very fine, as compared with those of the sand gravel, and broken stone with which the cement is mixed, the slightest current of water disturbs the cement, and a very large portion of it is washed away, so that in one part there is an excess of cement, and in another less than there should be, or perhaps none at all. In addition to this, in opening the skip and discharging the concrete a still further displacement occurs. Precautions to a certain extent can be taken against cement being carried off by currents, but there is always a dissipation or loss of strength irrespective of loss by waste, and which has been determined by numerous experiments as being upon an average, as nearly as possible, equal to about one-half of its strength out of water, and, therefore if it be desired to construct subaqueous work equal in strength to 8 to 1 concrete work out of water, it is necessary to use materials in the proportions of at least 4 to 1. It is quite an easy matter for any one to test this, and it will be seen even under most favorable conditions, by filling into a box, out of water, say, ordinary 6 to 1 concrete and allowing it to set for three months, and by placing some of the same concrete in a similar sized box filled with water, and displacing the same by the deposiding of the concrete in the box, that at the end of the three months the under-water work will be very much inferior to that of the out-of-water work, and most likely will be found to be not more than from one-half, or, perhaps, even one-third of the strength of the work done out of water. With due care, such as by the use of facing skips and very fine extra strong concrete, better results might be obtained in regard to the lessening of the separation of the materials used than by the use of ordinary skips; for by the latter the stones and other coarse materials roll out from the general mass and lodge in the corners and against the faces of the molds, and thus exceedingly defective work is obtained. Portland cement concrete in

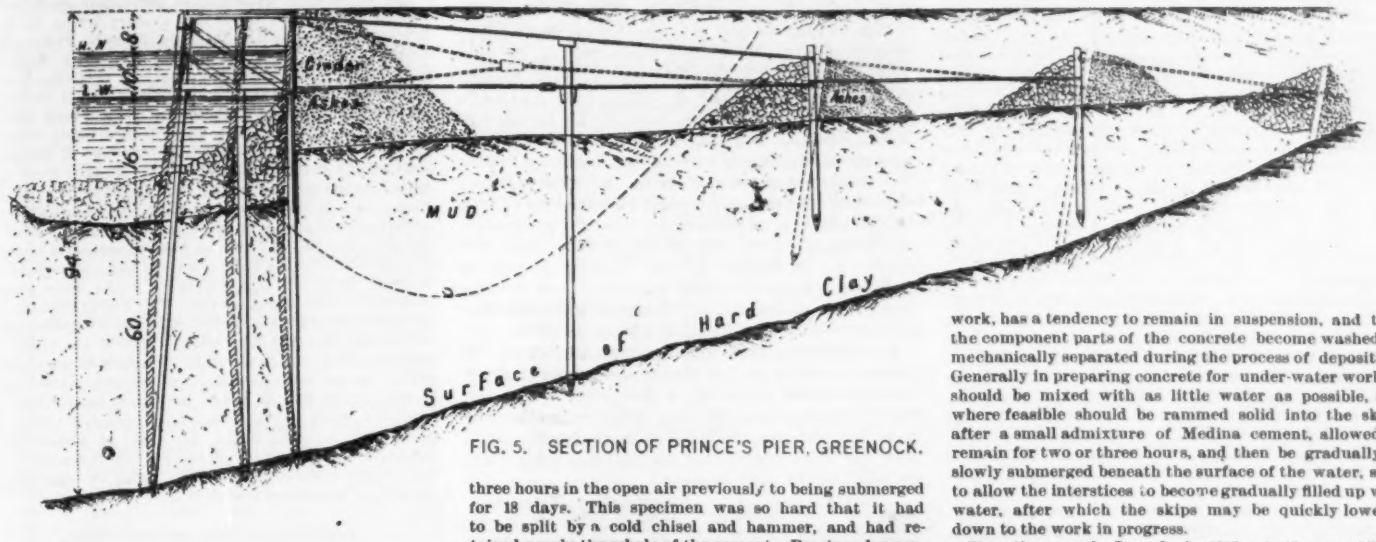


FIG. 5. SECTION OF PRINCE'S PIER, GREENOCK.

situ for work under water has occupied my attention for very many years, and with all the study and care which has been bestowed on it by engineers to insure sound work, and although in years past I have strongly advocated its use for monolithic work in subaqueous foundations, from the many indications in recent years that the life of such concrete is not likely to be that of centuries, I am almost led to the opinion that in the construction of all important sea works the use of rubble concrete blocks faced with masonry, and the finest quality of cement, selected from well-burned clinkers, used in the body of work, and for grouting up the bed and joints of the blocks, should supersede concrete *in situ*. I will describe what I mean in detail in my next lecture. In the years 1856 to 1858, when Portland cement was regarded as the newest material of the day for under-water work, I made a number of experiments with reference to this, the results of which I laid before the Institution of Civil Engineers in the year 1866.* I there stated that to obtain sound work without loss of cement it was absolutely necessary to keep the entire works clear of water, for it was not possible to obtain strong and sound concrete work under water, whether the water was quiet or not, that is, if the materials were thrown in dry immediately after mixing. I had ascertained that concrete in the process of being deposited in this manner, and with only 1 in. of quiet water over its surface as deposited, even in the proportions of 3 to 1, was most seriously weakened by the separation of the finer particles of the cement from the body of the concrete.

In the year 1865, in concreting an outer apron of a graving dock between the pointing sill and the coffer-dam at low water, I had used Portland cement concrete in the proportions of 4 of Thames ballast to 1 of cement. It was all put in at the same time, in the same manner, with the same cement and ballast, and by the same men in quiet water of not more than 1 in. in depth above the concrete as it was laid. The concrete was then allowed to remain three months, and at the expiration of that time I had occasion to examine it, when I found that the portions nearest the abutments of the entrance were sound, but in the center, or rather in the part last closed in, a considerable portion was found to be quite soft; in fact, it was ballast which had retained but a mere fraction of cement, and what was retained of the cement had about as much strength as pipe clay. The whole of the defective concrete had to be removed and replaced with new concrete after the water had been excluded. To avoid such a contingency in future, I resolved that all Portland cement concrete before being deposited under water should, after mixing, be allowed to partially set. The time allowed for the concrete to set before being deposited depends upon the newness and fineness of the cement used, the proportion of the cement to the sand and stone, and the state of the atmosphere. If these conditions be not strictly adhered to unsatisfactory results will be obtained. By numerous experiments I found I was able to retain nearly the whole of the cement, and obtain a much stronger and better concrete, in proportion to the quantity of cement used, than by the ordinary methods. I referred to several specimens which I then exhibited. One was composed of one part of Portland cement and one of fine river ballast; this was thrown into 6 ins. of quiet water dry immediately after being mixed, was submerged 18 days, at the expiration of which time it showed the great separation that had taken place even it quiet water. A second specimen, similarly composed, was also thrown into 6 ins. of quiet water, but not until it had been allowed to partly set, after being mixed for about two or three hours in the open air previously to being submerged for 18 days. This specimen was so hard that it had to be split by a cold chisel and hammer, and had retained nearly the whole of the cement. Passing dry concrete down chutes, even with their lower ends somewhat buried in the newly deposited concrete, did not prevent separation from the coarser and heavier materials, which descended much more rapidly than the cement; for the cement, if very fine, which it should be for under-water work, has a tendency to remain in suspension, and thus the component parts of the concrete become washed or mechanically separated during the process of depositing. Generally in preparing concrete for under-water work it should be mixed with as little water as possible, and where feasible should be rammed solid into the skips, after a small admixture of Medina cement, allowed to remain for two or three hours, and then be gradually or slowly submerged beneath the surface of the water, so as to allow the interstices to become gradually filled up with water, after which the skips may be quickly lowered down to the work in progress.

Since the remarks I made in 1866 as to the use of Portland cement concrete *in situ* under water, I have had considerable further experience in the various harbor and sea works executed by myself, and likewise from the examination of works I have visited, executed by other engineers, and my former opinions have more than ever

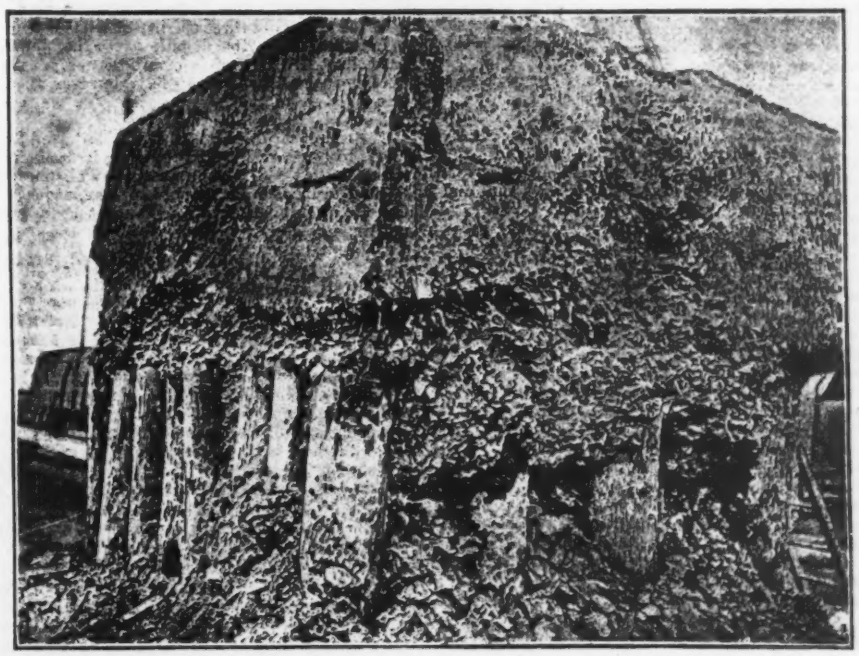


FIG. 6

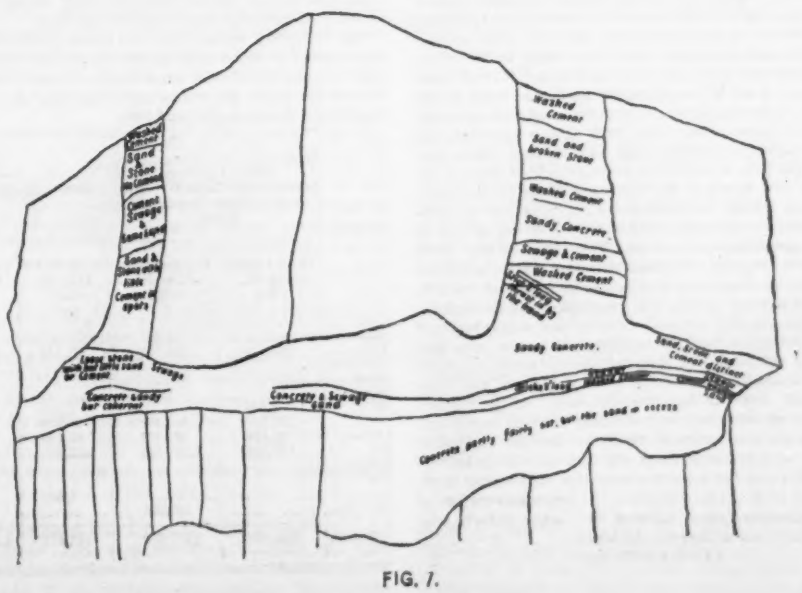


FIG. 7.

* See paper "On the Strength of Portland Cement." By John Grant, M. Inst. C. E., Proceedings of the Institution of Civil Engineers, Vol. XXV., page 125 (session 1865-6).

been confirmed as to the loss of strength and the uncertainty of obtaining sound work under such conditions, except at great cost for extra cement. As I have before mentioned, in order to guard as much as possible against the great loss of strength, I have in every work allowed the concrete to set one, two and three hours before being deposited in the work, or until it had become somewhat pasty or tacky, or just stiff enough to hold together while being passed through the water, but yet soft enough after it is deposited from the skips to fall to pieces, and to unite with the previously deposited concrete and so form sound work. At Greenock, Girvan, Wick, Quebec, and elsewhere, I have managed to get admirable work done by using partially-set concrete, where, if the concrete had been deposited immediately after mixing, much larger quantities of cement must have been used to obtain equally good work. However, under the most favorable circumstances, and where the greatest possible care is taken, there is always uncertainty about works constructed with concrete *in situ* under water, and if there were the same facilities for examination and detection of imperfect work done under water as for work done out of water, I am quite sure that engineers in the future would use it in connection with such works much less than they have done in the past.

I think I cannot do better than illustrate my remarks upon this point by reference to the condition of an experimental block of concrete constructed under the superintendence of General Newton, of the United States Army. The block weighed 80 tons, and the object of the experiment was to ascertain if the system of constructing some new quay walls then in progress in the North River, New York, was such as to secure sound work. The method pursued was to build a caisson, to lower it to the bottom of the harbor, deposit therein concrete in a similar manner and of similar proportions to what was employed in the construction of the quay wall, and when sufficient time had been allowed for the concrete to thoroughly set, the caisson with its contents was raised from the bottom of the harbor, its sides removed and the block of contrete examined. The caisson was about 10 ft. square, closely planked, and had a sloping face in front, corresponding to the batter of the wall, and short ends of piles were erected on the bottom of the caisson, similar to the bearing piles driven into the bottom of the harbor, and upon which the quay walls were built. After the caisson was completed it was sunk to the bottom of the harbor and filled with concrete, composed of one part of Portland cement to two parts of sand and four parts of broken stone. The materials as soon as mixed were filled into a skip having a sloping bottom and an opening side, and this was lowered through the water, and the concrete deposited. Next to the sides of the caisson forming the face of the wall, and at the corners of the caisson, the skips were guided in position and tipped by divers, so as to secure as sound work as possible. In order to make the block approximate as closely as possible to the quay wall, the caisson was not filled up in one day, but several days were occupied, the work thus being done in layers as in the quay wall. Five weeks after the caisson had been filled with concrete it was raised by a derrick crane, placed on shore, its sides removed, and the work examined. The removal of the sides was done with great care so that the concrete might not be disturbed. Several photographs of the different sides of the block were taken, one of which and a key diagram I have shown on Figs. 6 and 7.

The appearance of the block on the removal of the sides of the caisson was as follows: The faces were very ragged toward the bottom of the work, and on the river and south sides the ragged appearance of the faces extended to the top of the block. On the top of each layer of concrete (or day's work) there was a deposit of waste cement, which at the top of the whole mass was 6 ins. in thickness on an average. From this upper deposit a specimen was taken, and kept in a warm office for some weeks; there was no appearance of setting, and after it had been thoroughly dried it floated on the surface of fresh water. It would, therefore, appear that the cement had separated in a great measure from the bulk of the concrete, the heavier particles finding their way through the broken stone to the base of the block, and the lighter floating on the top; and this fact was borne out in the mass of concrete even where the setting was very good, the proportion of sand always apparently being in excess of that in which it was deposited in mass. The faces of the block against the planking exhibited very few stones, but there was a coating from ¼ in. to 3 ins. in thickness of cement, sand, and sewage having the appearance of stratified deposit. This coating, instead of being hard and capable of resisting abrasion from the rubbing of vessels, was soft and easily removed, and upon its removal strata were exposed of washed cement, sand, sewage deposit, and concrete, with more or less excess of sand. At the corners the defective work was more strongly marked, and in one place there was a cavity, of which the bottom and sides were of loose stones without any cement. An examination by divers of the subaqueous portion of the quay wall, which had been completed prior to the construction of the experimental block showed that were defects of a similar character to those in the block.

(To be Continued.)

Production of Steel, 1880-1890.

Census Bulletin No. 13 is a report on the production of steel in the United States during the year ended June 30, 1890, prepared by Dr. W. M. SWEET, special agent, under the direction of Mr. FRANK R. WILLIAMS, expert special agent of the Division of Manufactures. The tables presented show an aggregate production of steel of all kinds by States. The total production of steel in the form of ingots and direct castings aggregates 4,466,926 tons of 2,000 lbs. an increase of 290 per cent. over the production of the census year 1880, at which time steel was made in 14 States in the Union, as against 19 States engaged in that industry at the present time. The production of Bessemer steel rails has increased from 741,475 tons in 1880 to 2,036,654 in 1890.

The following table gives the production of the various kinds of steel in the form of ingots or direct castings in 1880 and 1890. A few steel works produce blister, cemented, and other miscellaneous steel, but the quantity made annually is very small, and the statistics thereof for 1880 and 1890 are not included in the table below:

Kinds of steel. (Ingots or direct castings.)	Year ending May 31, 1880.	Year ending June 30, 1890.
Bessemer steel	985,208	3,788,572
Open-hearth steel	84,302	504,351
Crucible steel	76,201	85,536
Clapp-Griffiths steel	.....	83,963
Robert-Bessemer steel	.....	4,504
Total	1,145,711	4,466,926

Pennsylvania continues to occupy the position of the leading producer of steel in the United States, producing 57% of the total production in 1880 and 62% in 1890. Illinois was second in rank in both years, and Ohio was third. From 1880 to 1890 the increase in production in Pennsylvania was 324%, in Illinois 241%, and in Ohio 314%. Since 1880 the manufacture of steel has been abandoned in two States, viz., Rhode Island and Vermont, and seven States have engaged in its production, viz., Alabama, California, Colorado, Indiana, Michigan, Virginia and West Virginia.

Pennsylvania, Illinois and Ohio produced 88.68% of the steel production in 1880 and 91.41% in 1890. The Southern States have as yet barely made a beginning. The report continues:

The Clapp-Griffiths and Robert-Bessemer processes were introduced into the United States during the past decade, the former from Great Britain in 1884, and the latter from France in 1888. Both processes are modifications of the ordinary Bessemer method, but the converters employed are nearly all of small capacity. The first steel made in this country by the Clapp-Griffiths process was produced at Pittsburg, Pa., March 25, 1884. During 1890 seven works contained converters for the production of steel by this process, five of which were in operation in that year, producing 83,963 tons of steel ingots or direct castings. No new plants have been erected since 1887, and none are now under construction. The first steel produced in this country by the Robert-Bessemer process was made at experimental works at Springfield, O., in September, 1888. During 1890 there were six completed works containing converters for the production of steel by this process, and one plant was in course of erection. The process may be said to be still in an experimental stage, but the results that have so far been obtained by its use are reported to be encouraging. During 1890 there were 4,504 tons of Robert-Bessemer steel produced in this country, principally in the form of castings.

The following table gives the production of Bessemer steel ingots or direct castings (the figures for 1890 including the quantity of steel made by the Clapp-Griffiths and Robert-Bessemer processes) and Bessemer steel rails in the United States in 1880 and 1890:

States.	Bessemer steel ingots or direct castings. (Including Clapp-Griffiths and Robert-Bessemer steel.)		Bessemer steel rails.	
	Year ended May 31, 1880.	Year ended June 30, 1890.	Year end'd May 31, 1880.	Year end'd June 30, 1890.
Cal.	.....	.....	.....	5,654
Colo.	.....	17,952	.....	14,286
Illinois.	253,514	867,805	201,186	622,260
Indiana	.....	.....	.....	.....
Mass.	.....	15,753	.....	.....
Mich.	.....	3,600	.....	.....
Mo.	8,409	.....	5,100	.....
N. Y.	84,160	105,402	57,870	.....
Ohio.	82,811	385,576	66,480	17,335
Pa.	556,314	2,297,726	409,339	1,377,119
Tenn.	.....	.....	.....	.....
Va.	.....	.....	.....	.....
Vt.	.....	.....	1,500	.....
W. Va.	.....	183,225	.....	.....
Total.	985,208	3,877,039	741,475	2,036,654

The remarkable growth that has taken place in the Bessemer steel industry of this country during the past 10 years is well shown by the above figures. The increase in the number of establishments producing Bessemer steel has been the result almost entirely of the demand for steel in forms other than rails. All of the 11 Bessemer steel plants that were completed in 1880 had been built to manufacture steel for rails, many of them being added to previously existing iron rail mills. Of the 53 Bessemer steel plants at the close of 1891 only 14 made steel rails during that year, and of the total quantity of rails produced over 90% was made by 10 of these works. Thus, while the production of steel rails has nearly trebled in amount since 1880, the number of establishments engaged in their manufacture has shown but little change in the 10 years, although many of these works have greatly increased in size and efficiency. The competition in the manufacture of Bessemer steel rails has compelled many of the rail mills to convert a large part of the steel produced by them into forms other than rails, the production of rails to any considerable extent at the present time being possible only in works favorably located for the supply of cheap raw materials and operated under the latest and most improved methods of manufacture. Included in the total production of Bessemer steel rails during 1890 were 65,273 tons rolled in iron rolling mills from purchased Bessemer steel blooms.

OPEN-HEARTH AND CRUCIBLE STEEL.

The production of open-hearth steel in the form of ingots or direct castings during 1890 amounted to 504,351 tons, as compared with 84,302 tons made during 1880. In 1880 there were 25 establishments containing open-hearth steel plants, located in 10 States, and in 1890 there were 58 establishments containing open-hearth steel plants, located in 12 States. Since 1880 the manufacture of open hearth steel has been abandoned in two States, Vermont and Rhode Island, and four States have engaged in its manufacture, New York, Alabama, Indiana and California. During the past few years great activity has taken place in the erection of open-hearth steel plants, and indications point to a still larger production of this kind of steel during the next few years.

The crucible steel industry has shown but little progress since 1880, the production in that year amounting to 76,201 tons, as compared with 85,536 tons produced in 1890. In 1880 there were 36 establishments containing crucible steel plants, located in 9 States, while in 1890 the number of establishments had increased to 47, located in 11 States. For purposes requiring special grades of steel the product of the crucible process will be always in demand, but the high cost of manufacture prevents it in many instances from successfully competing in price with the other processes mentioned.

THE BASIC PROCESS.

The first basic steel made in the United States was produced experimentally at Steelton by the Pennsylvania Steel Co., on May 24, 1884, in a Bessemer converter. The beginning of the manufacture of basic steel in this country as a commercial product, however, dates from 1888, on March 28, of which year the first basic open-hearth steel was produced at the Homestead Steel Works of Carnegie, Phipps & Co., Lim. Since that date the manufacture of basic open-hearth steel has been continued at these works, and during 1890 this firm commenced the erection of 8 additional open-hearth furnaces for the manufacture of basic steel, of which number 4 are now in operation, and the remaining 4 furnaces are expected to be ready for working in a short time. When completed these works will contain 16 open-hearth furnaces prepared to manufacture basic steel. The manufacture of basic steel is now also regularly carried on at the Steelton works of the Pennsylvania Steel Co., where a combination of the Bessemer and open-hearth processes is used. During 1890 the Henderson Steel & Manufacturing Co., at Birmingham, Ala., produced steel experimentally by the basic process. Since the close of the year the Southern Iron Co. has successfully commenced the manufacture of basic open-hearth steel at its works at Chattanooga, Tenn. The Pottstown Iron Co., at Pottstown, Pa., has also produced steel by the basic process.

In Great Britain and on the Continent the basic process has been received with great favor, and large quantities of basic steel are made annually by all the leading iron and steel producing countries abroad. The wonderful growth of the steel industry of Germany and Luxemburg during recent years has followed the introduction of this process, the iron ores of these countries being especially suited to the manufacture of basic steel.

While the basic process is applicable to either the Bessemer or open-hearth process, its use in this country in connection with the open-hearth furnace is most promising of successful results, and the indications are that the growth of the basic steel industry of the United States will be largely in this direction. The total production of basic steel in the United States during 1890 amounted to 62,173 tons, nearly all of which was made by the basic open-hearth method, a small part being produced by the duplex process, a combination of the Bessemer and open-hearth methods.

A Simple Method of Ditching and Grading.

The device here illustrated and described was invented by Mr. D. D. ROGERS, of Ocala, Fla., while in charge of a considerable amount of ditching near the east coast of that State. His laborers were all negroes, unaccustomed to such work; so great difficulty was found in keeping them to grade. Under these circumstances the plan of setting up targets about the height of the eye above the bottom of the ditch suggested itself. Rods 5 ft. long were made, graduated in feet, numbered from the top so that the depth of cut as marked on the grade pegs could be laid off from the top of the rods; and targets set at these points would give a line parallel to and 5 ft. above grade. The negroes seemed to understand the system at once, and in a short time those of them who were able to read the numbers on the pegs could be trusted to set the targets. The inventor states that in this particular case, which included a great deal of soft rock work, about 5 cts. per cu. yd. was saved by the adoption of the device, and that full 2 cts. per cu. yd. could be saved in all work of a similar nature.

FIG. 1.

Considerable improvement has been made in the apparatus since first used by Mr. ROGERS, some 10 or 15 years ago. The rod and plain target are now made as shown in Fig. 1. The rod is of pine 1⅛ ins. in diameter, of equal circular section throughout, marked off in feet and twentieths. The target is 15 ins. long, of the form shown in the cut, and has a small level on the back to keep it horizontal. It is fitted to a collar, which can be slid up and down the rod, and set at any required point by means of a clamping screw. The manner of using these rods in cases where the work has been staked to grade is so simple as not to require description (see Figs. 2 and 3). Where there are both cuts and fills, as in Fig. 2, rods of extra length are required, reading both ways from a zero at the 5-ft. point.

The leveling instrument, Fig. 4, is used to set targets when the line has not been already staked to grade. Suppose, for instance, it is required to run a ditch with a fall of 1 in 1,000 from a certain point where the depth of the proposed ditch is known. The instrument is placed on one of the rods and slid down until the upper edge of the collar is at the mark on the rod which indicates the depth of the ditch. It is then clamped to the rod by the screw *A*. The sights are directed in the course of the ditch; clamped by the screw *C*, and leveled with tangent screw *B*. An assistant with a plain target is now sent down the line, say 200 ft. His target is leveled from the instrument, and afterwards moved by him 0.2 ft. further down the rod. In the same way another target is set 0.4 ft. below the level of the instrument and 200 ft. further down the ditch, thus giving a line of targets parallel with the bottom of the ditch and 5 ft. above it, which can be produced as far as desired.

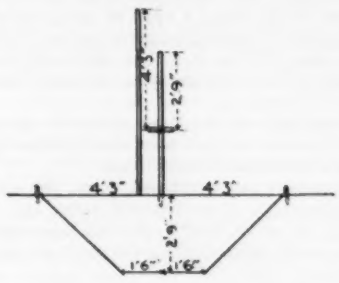


FIG. 5.

For setting slope stakes for ditches or for railway roadbeds (supposing a slope of 1 to 1) a rod is used as much over 5 ft. as half the width of the top of the roadbed or the bottom of the ditch. This rod is held on the line of targets and the point where the line intersects it is found. Then the portion of the rod above the line will be one-half the width of the top of ditch or bottom of roadbed at the point where the rod was held (see Fig. 5).

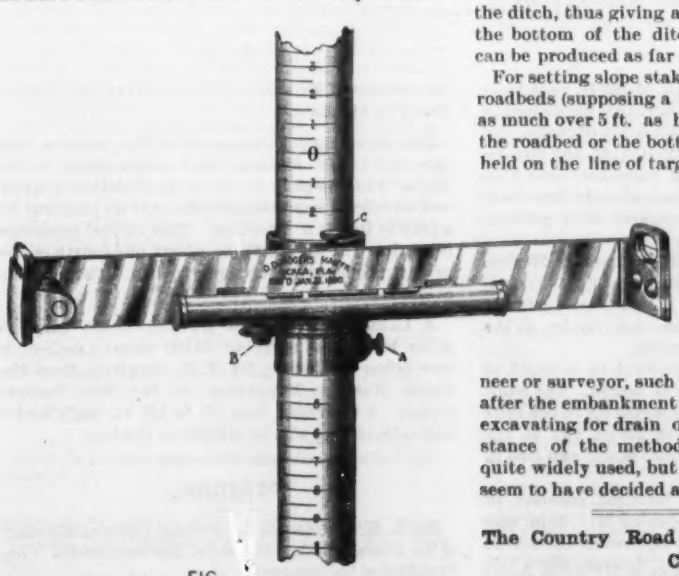


FIG. 4.

Other uses will suggest themselves to the engineer or surveyor, such as setting culverts before or after the embankment is built, bedding mud-sills, excavating for drain or water pipe, etc. The substance of the method in a cruder form has been quite widely used, but the instruments illustrated seem to have decided advantages.

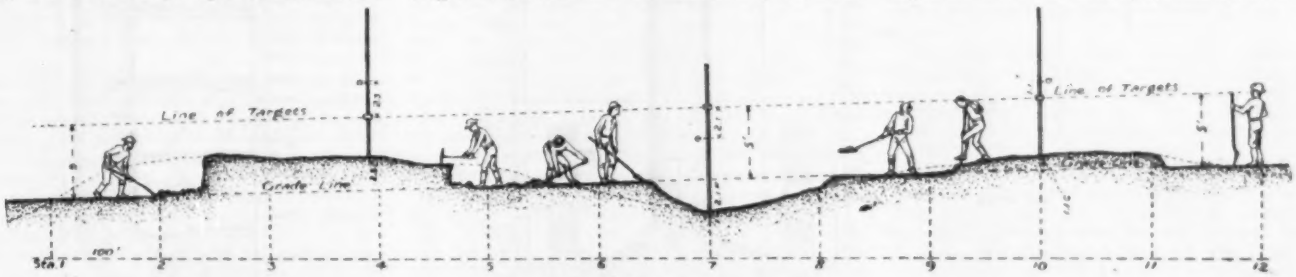


FIG. 2.

FIG. 3.

The Country Road Question in Allegheny Co., Pa.

The Allegheny Co., Pa., road convention held its meetings in Pittsburg, commencing Oct. 30, with Mr. GEORGE MCKEE, President, and Messrs. P. F. SMITH and W. H. ROBERT, Secretaries. The following recommendations were discussed and adopted: (1) Favoring the abolition of the present system of working out road taxes, and substituting a cash tax instead. (2) Favoring State aid to public roads. (3) Favoring distribution of this aid to the counties, instead of to townships; and ascertaining the amount of aid by valuation of assessable property, instead of by number of inhabitants, road mileage or otherwise. (4) Supervisors of roads should be paid, and their duty should be the assessment of taxes and appointment of road overseers having direct charge of work. (5) County engineers should attend to road making and act as superintendents; but the State aid should be handled as are the local taxes. (6) Allegheny County was classified as an agricultural, manufacturing and mining county, with (7) county stone fit for road making. (8) Favoring the borrowing of money by townships for road purposes. (9) The subject of convict labor on roads and in preparing road material caused a lively discussion, but was finally carried in the affirmative. These remmendations were ordered to be embodied in the general report to the Pennsylvania Road Commission, with the right to make further recommendations.

In support of these resolutions, Mr. PATTERSON said that the expenditure of $100,000 in his township, Chartiers, would enhance the value of the township $1,000,000. In regard to money borrowed by the townships, the meeting has yet to act on the detail of the resolution. As now before them this resolution would give the right to borrow to an amount equal to 5% of its taxable value and issue therefor 20-year 6% bonds. Any tax payer who would pay double his township assessment would have the right to have his entire payment applied in any local improvement of the roads that he may direct. The committee is to meet in two weeks and report to the State Commissioners on these and other resolutions before them.

English Ordnance Maps.

Capt. C. E. HAYNES, R. E., states that the large-scale maps of the Ordnance Survey are printed on double elephant machine-made drawing paper, the expansion of which, due to humidity, is greatest in its length. Being a hard paper, it is necessary to print from the zinc plate on damp sheets, which contract on drying, in length chiefly; consequently, the form on the plate should have a similar elongation. The negative is taken true to scale, and a photographic transfer prepared, after the Southampton method, on Evans' double elephant thin paper, which likewise has its greatest expansion in length. Previous to transfer to zinc, the transfer is damped until it has expanded to a certain convenient length—in practice, about ¼ in. beyond its correct size—and quickly passed through the zincographic press; the scraping action of the press increases the length of the transfer by a slight variable amount, which can be determined by experiment. The printer then obtains a stock of paper for printing that has been damped to such a degree of expansion as will contract on drying to the correct scale. In the paper-damping department a stock of printing paper is kept sorted in various degrees of expansion to suit the variable sizes of form on the zinc plates. Every sheet of paper used for printing is measured before being damped, after being damped, and again after being printed. Prints

with $\frac{1}{630}$ or .16 per cent. of error in scale are cancelled It is found that the elasticity of paper—*i. e.*, its capability of regaining its original form on drying after being damped—depends on its maturity, and that the maturity of a sheet depends on its age, and to a certain extent on its position in the ream.—*English Mechanic* (London).

The Niagara Falls Power Co.

In ENGINEERING NEWS for May 17 and 24 we gave a map and sections of the canals and tunnels proposed by the Cataract Construction Co., and a description of the geological formations which would be encountered in developing these remarkable plans. Since then the tunnel driving was begun, as already noted in these columns, and the following details have been adopted:

The company has decided to construct a tunnel of 490 sq. ft. section, shown in Fig. 1, on a slope of 0.7 here the tunnel continues parallel with the bank for 1½ miles at an average depth of 160 ft. below the ground. It is connected with the river by means of surface conduits or canals, through which water is carried to the shafts and wheel pits.

The works are designed to develop 120,000 HP., and are divided, for convenience of construction, into three sections. The water passes through turbines, as shown in Figs. 2 and 3, and the power developed thereby will be transmitted to the surface, as shown in the cuts, whence it will be delivered by cable, pneumatic tube or electricity as the customers desire.

The company will also lease power to customers wishing to excavate their own wheel pits and put in their own wheels and connections.

The company has purchased about 300 acres of land, beginning a short distance above the upper boundary line of the New York State Reservation at Niagara, and extending along the shore of the river for 2 miles, at an average depth of 600 ft. back from the river, assuring to the company this entire length of river frontage with its facilities for dockage, and furnishing ample room for mill sites of any size desired. There have also been purchased over 1,000 acres of land adjacent to that already described, which will be used for mill sites, and more particularly for homes for operatives.

The contract under which the contractors Messrs. RODGERS & CLEMENT are working, calls for the completion of the tunnel by Jan. 1, 1892; the contracts for the canal and wheel pits are not yet let, as the final plans have not been approved.

Two shafts have already been sunk to a depth of 200 ft., and a 30° portal incline is begun. The work has all been done by hand, averaging 0.9 ft. per shift in the shafts and amounting to 200 cu. yds. at the portal; one shift working in the latter and two in the shafts.

The plant which is being installed consists of eight 100 HP. boilers, three duplex 18 × 30-in. and two single 12 × 16-in. Rand compressors, three Otis hoists of 25 HP. each, a 100-light dynamo and a full complement of blowers, pumps and other machinery. The boiler house will be 34 × 92 ft. and the engine house 40 × 112 ft., all located at shaft No. 2. Air will be conveyed from this point to shaft No. 1 in 6¼-in. pipes, and thence to the portal in 4-in. pipes. Compressed air will be used for the drills, hoisting and pumping machinery at the portal and shaft No. 1; at shaft No. 2 both air and steam will be employed.

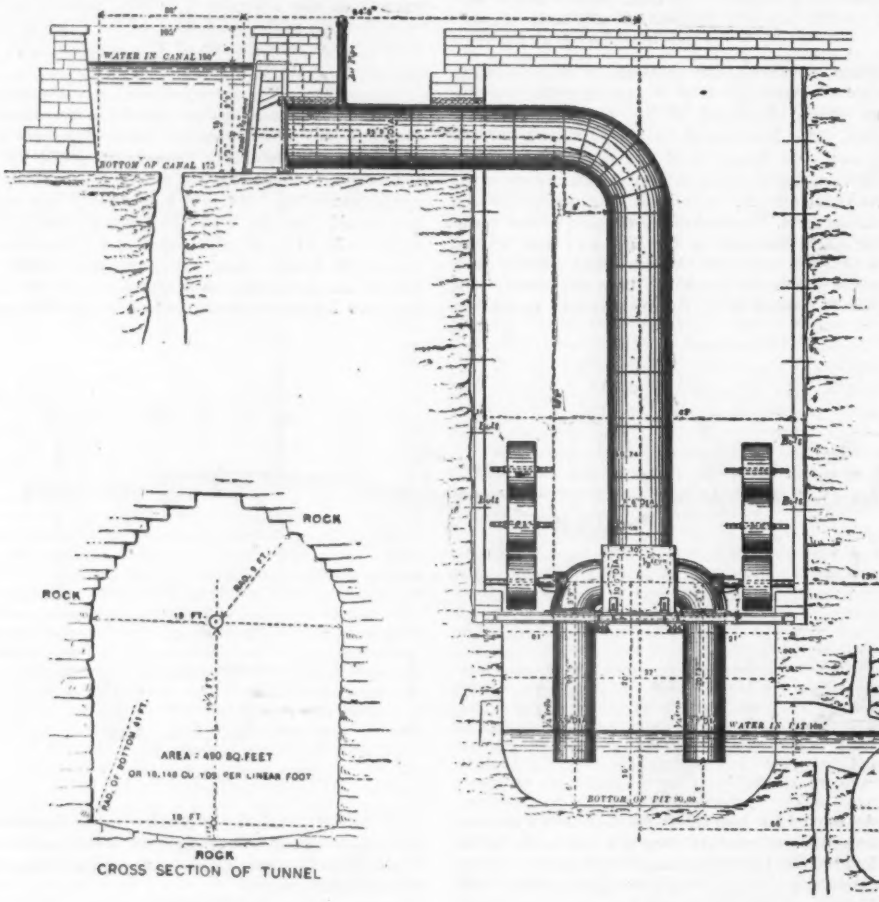


FIG. 1.

FIG. 2.

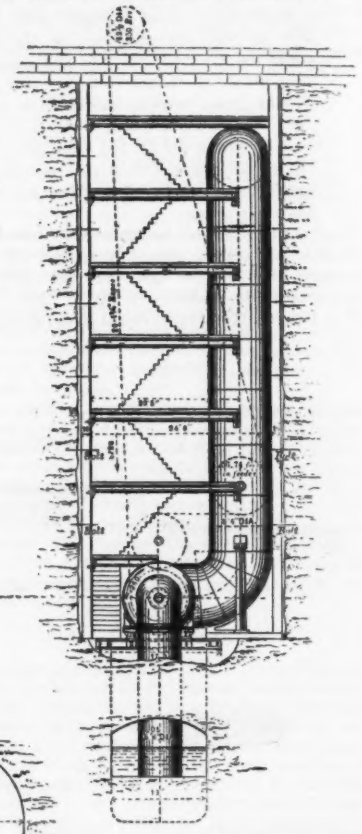


FIG. 3.

in 100 ft. While a circular tunnel running full would be of the form that would present the least surface resistance to the flow, yet the engineers have decided that the above shape is best adapted to the requirements. The section is rectangular, with a semi-circular arched roof; the width is 18 ft., height to spring of arch 19.48 ft., radius of arch 9 ft., radius of floor 41 ft.

The bottom of the tunnel, where it discharges into the lower river, will be, perhaps, more than 20 ft. below average water level so that when completed, only the arched roof will be shown above the river.

. While a canal 270 ft. wide, with 10 ft. depth of water flowing through it, at the rate permissible in an unwalled channel, would be required to convey the water from the upper river to the brink of the chasm made by the lower river to there develop the power now proposed to be applied to useful work, the same amount of power, it is assumed, can be obtained on the Evershed plan by means of a tunnel passing under the town, the sectional area of which is only 490 sq. ft., and in which a velocity can be maintained of over 25 ft. per second.

This tunnel will begin a short distance below the Falls, and extend in a straight line to a point 400 ft. from the river, about a mile above the Falls. From

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THE AM. SOC. C. E. NOMINATIONS for officers for the ensuing year, as reported at the last meeting Nov. 4) by the Nominating Committee, are as follows: For President, OCTAVE CHANUTE; for Vice-Presidents, JOHN BOGART, CHAS. HERMANY; for Secretary, JOHN C. TRAUTWINE, JR.; for Treasurer, GEO. S. GREENE, JR.; for Directors, THEODORE COOPER, CLEMENS HERSCHEL, EDWARD P. NORTH, residents, and RUDOLPH HERING and S. WHINERY, non-residents. Of the ten nominees, five have been in the Board of Direction before, but only two are at present members of the Board. The most notable change is the nomination of Mr. JOHN BOGART as Vice-President instead of Secretary, and the nomination of Mr. JOHN C. TRAUTWINE, JR., as Secretary in his place.

THE SCHUYLKILL NAVIGATION CO., which a year ago tried to sell its canal and water-rights to the city of Philadelphia for over $6,000,000, has lately had an official appraisement made of its property by a jury of its own selection. This official valuation is set down at $1,539,221, or about one-fourth of the price it proposed to charge the city. The moral is evident.

A LARGE LUMBER AND WATER FLUME, some 43 miles long, and carrying 50,000 miner's inches, is now being located, by Mr. J. M. GRAHAM, from the Sierra Nevada Mountains to the San Joaquin plains. A reservoir dam 100 to 125 ft. high and a half-mile tunnel will be needed on the line.

PERSONAL.

Mr. D. H. GOODMAN, the present General Manager of the Union Switch & Signal Co., has been elected Vice-President of the company.

Mr. JOHN SCOTTI, said to have been the inventor of the locomotive cab, died Nov. 2 in Baltimore. He was connected with the Baltimore & Ohio R. R. throughout his life.

Superintendent McCOY, of the Buffalo Division of the West Shore R. R., has resigned, and succeeds Mr. E. G. ALLEN as Superintendent of the Hudson River Division of the New York Central R. R.

Mr. C. T. DABNEY, until recently with the Chesapeake & Ohio Ry., has been appointed Superintendent of the Buffalo Division of the Western New York & Pennsylvania R. R., vice Mr. HENRY DWYER, resigned.

Mr. J. B. ROHRER has been promoted from Resident Engineer, in charge of 40 miles of construction, on the Ohio Extension of Norfolk & Western Ry., to Division Engineer in charge of 90 miles of construction on the same extension, vice Mr. JOHN RAPELYE, resigned.

Mr. WILLIAM WASHBURN, one of Boston's leading architects, who died suddenly in that city Oct. 31, was a native of Lyme, N. H., where he was born Oct. 7, 1808. At an early age he came to Boston and here learned the carpenter's trade. In a short time he became a builder and rapidly advanced to the front, both in reputation and in amount of business. At that time there was no school of architecture in Boston, but Mr. Washburn by dint of his own personal enterprise and quick perceptions mastered the profession. Although he made a specialty of hotels, his attention was by no means confined to that branch, and a number of admirable public buildings, among the Tremont Temple, bear witness to his excellent taste. His method of roof trussing has never been equaled, and students of architecture are to-day taken to Tremont Temple to study the trussing there.

SOCIETY PROCEEDINGS.

Civil Engineering Society of the Massachusetts Institute of Technology.—Meeting of Oct. 30. The constitution was so amended as to abolish junior membership. Time of meeting was also changed to once in three instead of once in two weeks. The next meeting will be on Nov. 20. At this meeting Mr. A. G. ROBBIN described the application of graphics to some algebraic problems and Mr. F. H. KENDALL read a paper on "The U. S. Coast Survey."

American Society of Civil Engineers.—At the meeting on Nov. 5, the President, Mr. W. P. SHINN, read the report of the Nominating Committee for officers for the ensuing year. The nominations were as follows: President, OCTAVE CHANUTE; Vice-Presidents, JOHN BOGART, CHAS. HERMANY; Secretary, JOHN C. TRAUTWINE, JR.; Treasurer, GEO. S. GREENE, JR.; Directors, THEODORE COOPER, CLEMENS HERSCHEL, EDWARD P. NORTH, RUDOLPH HERING and S. WHINERY.

Mr. COOPER said that he thought the Nominating Committee ought to consult members nominated as to whether they would serve if elected. He had not been consulted and should certainly have declined the nomination.

Mr. CROES said that he was surprised at the report, as one of the nominations was contrary to the constitution and to the State laws under which the Society is incorporated. He claimed that officers must be Members, and that Associates and Juniors, not having voting powers, were not members in the sense required by law. He therefore considered that Mr. JOHN C. TRAUTWINE, JR., was ineligible for the office of Secretary, and that his name should be omitted from the list of nominations when presented to the Society to be voted upon.

The paper of the evening, on "Self Purification of Water in Flowing Streams; a Biological Consideration," was then read by the author, Dr. CHAS. G. CURRIER, M.D. The paper entered largely into bacteriology, described the methods of testing water for bacteria, etc., and referred to examinations made by the author on the water of rivers in various parts of the country. The paper was of an important character, although not of very general interest. After some little discussion Mr. FTELEY suggested that, as the subject was one of importance as regards water supply, and the time was late, Dr. CURRIER should be invited to continue his remarks at another meeting. The invitation was accepted by Dr. CURRIER.

The following candidates were declared elected:

MEMBERS.

FRANCIS R. FAVA, Prof. of Civ. Eng., Corcoran Scientific School, Washington, D. C.

ALEX. E. KASTL, First Asst. Eng., Panuco Riv. Impt., Tampico, Mex.

JOHN N. OSTROM, Bridge Engineer, New York City.

JAMES RITCHIE, Pittsburg Testing Laboratory, Pittsburg, Pa.

ASSOCIATE.

HENRY S. JACOBY, Asst. Prof. Civ. Eng., Cornell Univ., Ithaca, N. Y.

JUNIORS.

HENRY L. DAVIS, City Eng.'s Dept., New Haven, Conn.

WALTER L. DUSENBERRY, Dept. of Parks, New York City.

GEO. H. PAINE, Union Switch & Signal Co., Swissvale, Pa.

LEE TREADWELL, Pacific Short Line Bridge Co., Sioux City, Ia.

A. L. SHREVE, City Eng.'s Dept., Baltimore, Md.

Western Society of Engineers.—Meeting of Oct. 1, 1890, President L. E. Cooley in the chair, and some 60 member sand visitors present.

Mr. O. Chanute, for the Committee on "Bridge Legislation," stated that the committee had had some meetings. It has entered upon the gathering of data and has succeeded fairly well in getting some of them. The committee has undertaken to ascertain, first, what legislation concerning bridges has been had in foreign countries, and it has obtained the legislation in Great Britain, France, Austria and Germany, of which it will give an abstract in its report. It has also obtained the data concerning legislation heretofore proposed in the United States, and has also obtained data concerning the practice of the leading railroads in the United States, more especially in regard to bridge floors, which is considered the one important thing for legislation to touch upon.

Mr. Isham Randolph then read an interesting paper on "Railroad Signaling and Interlocking."

Mr. HANSEL, Consulting Engineer of the Railway and Warehouse Commissions in discussing this paper said, in regard to couplings: "I have a great deal of respect for the action of the car builders, and think that, while we have not yet got hold of the ideal coupler, that if we settle upon a type, the inventor will give us the proper design. As uniformity in everything is what we ask for, I am against any action of our State Legislature as regards any safety appliance which is not only interstate but international. We all know that our traffic is not confined within the United States. It goes to Canada and old Mexico, and any law that any State would pass would be an evil. I have advocated the idea that if the Congress of the United States would pass a law requiring couplers and air brakes of a certain style on all cars as they were repaired, and all new cars as they were sent out, and the provisions of this law were carried out in each State through its commissioners, it would be a good thing. Massachusetts and some other States have asked Congress to authorize the Interstate Commerce Commission to handle this subject. I think if the commissioners of all the States were authorized to act in this matter, they could do it. Figuring 557 cars for each 100 miles of railroad operated, we would have something like 55,000 freight cars in Illinois, and there are 237,000 freight cars owned by companies operating in Illinois. If we count on 19 engines for each 100 miles of operated line in Illinois, we would have 1,800 engines, which to equip with air brakes on engine and cars would cost over $3,000,000, or 8½¢ of the gross freight earnings of all the companies of Illinois, so that we see that we cannot command the introduction of any device of this kind except by degrees.

The Master Car Builders have been the only society who had nerve enough to come forward and say "We will adopt a certain line of car coupler," a certain type of air brake. Commissioner Mason says, in his annual report of '89, that the introduction of automatic couplers has not been attended with the result he hoped for, and I think that no good will come out of the automatic coupler question until Congress says that the type of coupler shall be so and so. I do not mean to say that the style and device should be exactly so, but the type shall be so and so. After they have decided that question it is easy enough for each State to act in harmony. Otherwise, the State of Michigan will allow them to put in any one of the thous. and types that we have, whereas Ohio would select a few and Indiana would select a few—all different so that it does not seem to me that any action of State Legislature will ever solve the problem.

Further discussion followed, by the President and Messrs. Randolph, Strobel and Williams.

JOHN W. WESTON,
Secretary.

Western Railway Club.—At the meeting on Oct. 21, the first subject discussed was steel-tired wheels, Wm. Forsythe Chairman of the Committee appointed upon the topic, repeated his statement made at a former meeting that on the Chicago, Burlington & Quincy, the swing beam truck is costing so much more to maintain than the rigid trucks that it is gradually being abandoned. He quoted from the report of the Committee of the American Society of Civil Engineers on Rail and Wheel Sections, the paragraphs referring to causes of sharp flanges, and read the following letter from a member of the Committee, written in response to his inquiry for any difference in flange wear observed with the two classes of trucks.

NEW YORK, Oct. 17, 1890.

WM. FORSYTH, ESQ., C., B. & Q. R. R. Co., Aurora, Ill.

DEAR SIR.—Your letter as to the "comparative effect of swing bolster trucks and flange wear of wheels," has been duly received.

I do not wonder you find it extremely difficult to get any definite information on the subject, for if any definite information exists, I do not know of it. I have sought for it very carefully at various times, but all I can give is an opinion based upon general observation. That opinion is, that swing bolsters do have a beneficial effect upon wear and tear in this respect: that they prevent the tremendous inertia of the car body from violently driving the flanges of the wheels against the rails whenever there is any imperfection of track or truck. Otherwise than in this respect, I regard it as quite certain that swing bolsters have no effect whatever on curve resistance. This becomes clearer when we remember that the *real* car after all is the truck, and the car body is merely a dead load resting upon it. Just so much effect in easing the motion as would be obtained by swinging any other heavy load carried on the car body in slings, is obtained by using swing bolsters *and no more;* and this is merely to ease off the more violent motions. On the other hand, I think in certain cases the swing motion may have a somewhat *injurious* effect on safety, by prolonging the pressure of impact after the wheels have struck, and so creating more tendency for them to mount. Of one thing I feel quite certain: that a very large proportion of the derailments commonly ascribed to spreading of rails, bad gauge, wrong flange, and unexplained causes, are in fact, due to such mounting for no obvious reason. I therefore do not regard swing bolsters as an extremely important appliance, but on the whole, I believe they do good enough to justify their existence.

There is a broad distinction between swing motion of car trucks and of locomotive trucks, owing to the fact that the last is rigidly attached to a long heavy controlling wheel base, while the car truck is not. The mechanics of the locomotive truck you will find very fully discussed on pp. 421-434 of my book on the Theory of Railway Location, chapter on Locomotive Running Gear. I can add nothing to this discussion.

Yours truly, A. M. WELLINGTON.

Mr. Forsyth called special attention to the statement that while shocks may be eased by the swing beam truck, when they occurred there was a tendency to hug the rail which might be dangerous. His conclusion was that there was not enough gain in the swing beam truck to justify its extra first cost and expense of maintenance.

The Secretary read a letter from J. C. Barber, M. C. B. No. Pac. Ry., objecting to the ordinary patterns of swing beam trucks because of their numerous parts, especially the spring hangers, which require welding, as this is often imperfectly done, also the coil springs, which are subjected to a heavy rocking strain. He favored, however, a swing beam truck, made with short hangers, to limit the swinging motion within narrow limits, and stated that his experiments showed that such a truck saved 20% in wear of flanges and journal bearings over the rigid truck. The maximum swinging motion should not be more than ¾ in. or less than ¼ in. each way from the center. The trouble with swing trucks, as ordinarily built, is that they are permitted to swing from 1½ ins. to 4 ins. each way from the center. It is unfair to compare such a swing truck with the latest modern designs of rigid truck.

As to side bearings not curving properly, the fact is that the proper use of side bearings is merely to prevent the rocking motion of the car. Increase the size of the bolster so that it will not spring down under a heavy load, and there will be no more trouble with the side bearings binding when the truck rounds a curve.

It has also been said that a swing bolster springs backward and forward in switching and springs the iron truck transoms outward. The cause of this is faulty construction. A swing bolster that bears against the iron transoms for the full length will never spring the truck transom, except perhaps in severe wrecks.

Mr. Barber also sent a model of the swing beam truck which has been used for 6 years on the Northern Pacific. As compared with the old pattern, the number of separate parts has been reduced over 80 per car, the first cost has been reduced 12½%, the maintenance has been reduced fully 60% and the capacity has been doubled.

Mr. Verbryck brought up the matter of the swing beam trucks used on passenger cars to make them ride easily. Mr. Hickey explained that with the small amount of swing permitted on a passenger car truck it was practically a rigid truck. Mr. Gibbs said the Chicago, Milwaukee & St. Paul was in favor of the swing beam truck, but had adopted a rigid truck for their cars of large capacity. The swing beam truck is a failure when loaded beyond its capacity. Mr. Cooke said that swing beam trucks worked very well until loads of 40,000 lbs. or upward were put on them. Then they swing to one side and draw harder than a rigid truck. He had noticed no difference in flange wear.

Mr. Schroyer and Mr. Barr defended the swing beam truck. The former thought the side motion which it permitted might be necessary in using the M. C. B. drawbars. The latter referred to experiments in carrying a bucket of water on a rigid truck car and on a swing beam truck car. The first spilled nearly all the water out of the bucket, but the swing beam car spilled out only half to three-fourths of the water. It was argued from this that the swing beam truck carried both the car body and the freight contained with less injury than the rigid truck. Mr. Mackenzie criticised the experiments, however, as not fairly made.

Mr. Rhodes gave the difference in first cost on the C., B. & Q. as $3.50 per truck in favor of the rigid truck. He expected to make as great a saving in cost of repairs as in first cost. Mr. Mackenzie suggested that the rigid truck was the best where roads were kept in first class condition; several members, however, said that if that was the case there was still great need of the swing beam truck. Mr. Darrall favored the swing beam truck and promised to submit statistics showing the decrease of flange wear and increased life of wheels since that truck was adopted on the Illinois Central.

After the intermission Mr. G. W. Rhodes read a paper on "Steel-tired Wheels and Methods of Fastening Tires" [abstracted in another column]. At the meeting on Nov. 18 Mr. Rhodes' paper will be discussed, and Mr. C. A. Schroyer will present a paper on "Draft Rigging."

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.

Vol. XXIV. Saturday, November 8, 1890.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

Technical Society of the Pacific Coast.—Next meeting Dec. 5. Secy., O. von Geldern, 408 California St., San Francisco.

Association of Civil Engineers of Dallas.—Next meeting, Dec. 5. Secy., E. K. Smoot, Elm and Austin Sts.

New England Railroad Club.—Next meeting, Nov. 12. Secy., F. M. Curtis.

Engineering Association of the Southwest.—Next meeting, Nov. 13. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Engineers' Club of Minneapolis.—Next meeting, Nov. 13. Secy., F. W. Cappelen.

Engineers' Club of Philadelphia.—Next meeting, Nov. 15. Secy., Howard Murphy, 1122 Girard St.

Western Railway Club.—Next meeting, Nov. 18. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery, Bldg.

American Society of Civil Engineers.—Next meeting Nov. 19. Secy., John Bogart, 127 E. 23d St., New York.

Boston Society of Civil Engineers.—Next meeting, Nov. 19. Secy., S. E. Tinkham.

New York Railway Club.—Next meeting, Nov. 20. Rooms, 113 Liberty St.

Engineers' Club of Cincinnati.—Next meeting, Nov. 20. Secy., J. F. Wilson.

Engineers' Society of Western Pennsylvania.—Next meeting, Nov. 21. Secy., S. M. Wickersham, Pittsburg, Pa.

Denver Society of Civil Engineers.—Next meeting, Nov. 24. Secy., Geo. H. Angell.

Civil Engineers' Society of St. Paul.—Next meeting,

Engineers' Club of St. Louis.—Next meeting, Dec. 8. Secy., W. H. Bryan, 30 South 7th St.

Civil Engineers' Association of Kansas.—Next meeting, Dec. 3. Secy., J. C. Herring, Wichita, Kan.

Dec. 1. Secy., G. L. Wilson.

Civil Engineers' Club of Cleveland.—Next meeting, Dec. 9. Secy., A. H. Porter, 50 Euclid Ave.

Western Society of Engineers.—Next meeting, Dec. 9. Secy., J. W. Weston, 230 La Salle St., Chicago.

THE nominations for officers for the ensuing year of the American Society of Civil Engineers, as given in another column, are of more than usual interest in the change made in the important office of Secretary, Mr. JOHN BOGART being nominated as Vice-President instead of Secretary, and Mr. JOHN C. TRAUTWINE, Jr., being nominated in his place for the latter office. Such a change has been more or less expected for several years, Mr. BOGART's multiplying professional engagements having seemed to make the change imperative, but the difficulty of finding a suitable candidate to succeed him (which has at last, we think, been most satisfactorily met) and the general appreciation of his long and in many ways important and distinguished services to the society and qualifications for the office, have postponed the change until now, although for several years he has been able to give only a small fraction of his time to the business of the society; which, if the society is to flourish as it should, imperatively demands the constant and undivided attention of the Secretary himself, and not merely of clerks under him. Mr. BOGART became a member of the society in 1869, about two years after its reorganization, when the society numbered about 100 members only. He became a director in 1872, treasurer in 1875 and secretary in 1877, so that he has held office continuously for nearly 19 years, during all of which period he has taken a leading part in the management of the society's affairs. In retiring from the office which he has held so long he will carry with him the best wishes of the membership generally, and he will be generally felt to well deserve the nomination to the higher but less exacting office for which he has been named.

THE new nominee for Secretary, Mr. JOHN C. TRAUTWINE, Jr., unites in one person more of the qualities which go to make the ideal Secretary than can often be found, unless by some rare chance. He bears an honored name, known to engineers throughout the world; he is perhaps as thoroughly versed in engineering literature as any one engineer in America, and so will make an admirable editor of the society's transactions, and guardian of its library, the last of which, as we have often said, has been for some years in a deplorably neglected condition. At the same time Mr. TRAUTWINE some years ago definitely gave up the active practice of engineering, and in consequence still remains an Associate only of the Society, as is Mr. JAMES FORREST of the Institution of Civil Engineers, although the Institution could much better have afforded to lose some dozens of its full members than the services of Mr. FORREST, who has played a leading part indeed in making the Institution, to which he has devoted the thought and energies of a lifetime, what it is to-day. We deem it for many reasons highly desirable that the Secretary of a society of engineers should not be himself a practicing engineer, and yet, it will rarely happen that a man who is not himself in practice will have the necessary intimate knowledge of engineering and engineers which Mr. TRAUTWINE has. He is also, to our knowledge, one of the most systematic and energetic of men, and thoroughly familiar with printing and publishing practice, qualities of great importance in an efficient secretary; and last, but not least, he is in his personal and social qualities, it seems to us, admirably suited to the place. It is not to be expected that any successor will unite in his person all the admirable qualifications for the office of the retiring secretary; few men do; but on the other hand, Mr. TRAUTWINE has decided merits of his own which make us feel sure that in his hands the interests of the society will not suffer; but rather, that its influence and usefulness will go on widening and broadening.

THE question of the right of the society to elect an Associate to the office of secretary was raised at the meeting by one member only, as noted in another column; but he found no seconder to his objections, nor is it surprising that he did not, since both the constitution of the society and the law of the State of New York are perfectly clear on the subject. The law of the State under which the society is organized, says:

> Any five or more persons may associate themselves [etc.] The persons who shall have signed and acknowledged such certificate and their *associates* and successors, shall be a body politic and corporate . . . to elect and appoint the officers and agents of each society. . . . The society so organized may annually elect *from its members* its trustees, directors or managers, *at such time and place, and in such manner, as may be specified in its by-laws.*

Now, let us see what those "by-laws" say, as to who is a "member," in Art. II., Sec. 1, of the late codification:

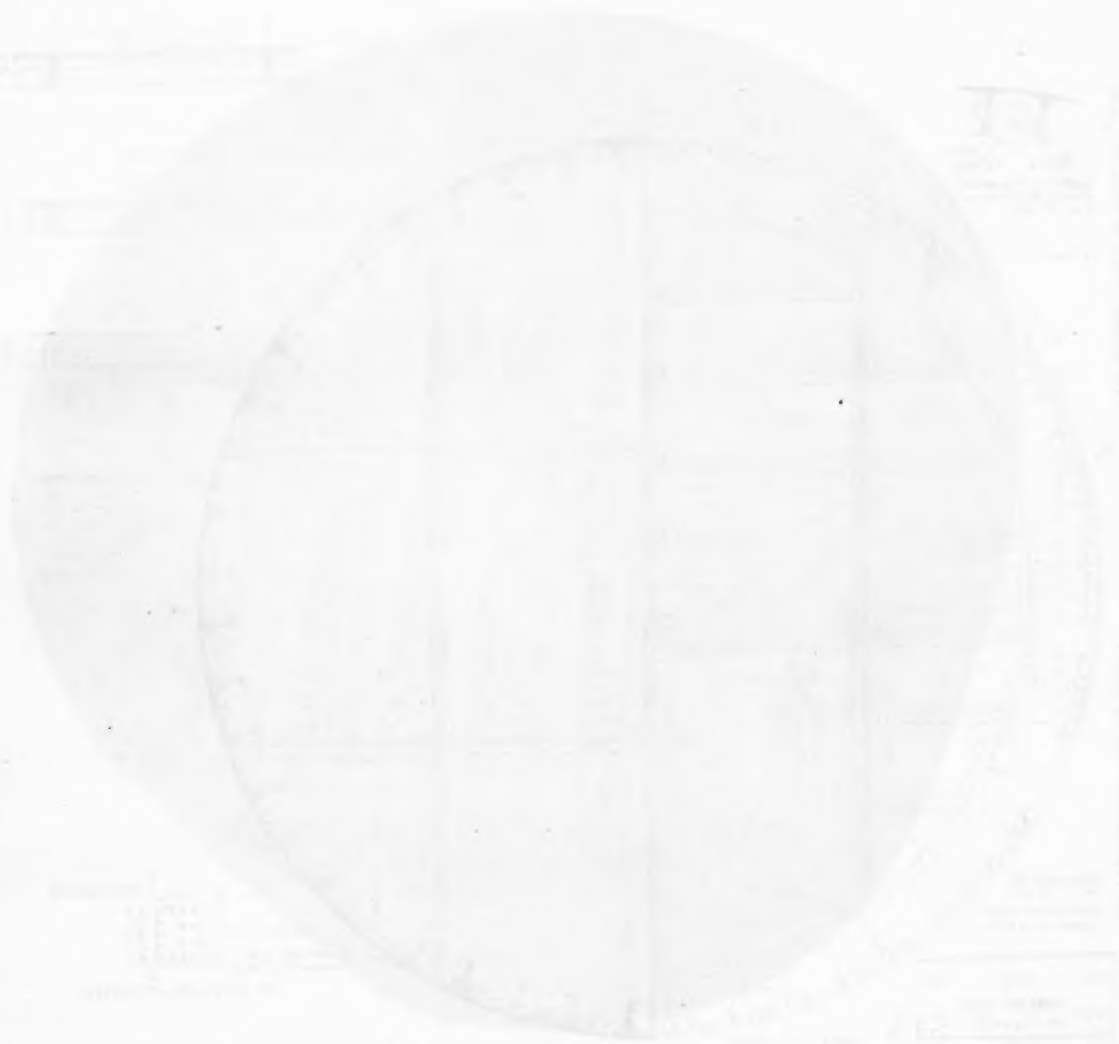
> *The Active Members* of the Society shall be divided into *three* classes, to be styled, respectively, Members, *Associates* and Juniors. *Associates and Juniors shall possess* ALL *the rights and* PRIVILEGES of Members excepting the right to vote.

If the right to be nominated and elected to office is not one of the "rights and privileges" of members, which is distinct from and in addition to that of voting, what is it? And by this clause it is distinctly and in the broadest terms conferred upon all of the three classes of "active members"; nor is there anywhere else even the remotest implication to a contrary effect. Thus, it was entirely within the power of the Society to have specified in its "by-laws" that the President, Secretary, or any other officer, must be a full member, or a member of a certain number of years' standing, or a resident of New York City, or conform to any other condition not of an unlawful nature which it chose to impose. It has done none of these things, and therefore the express words in which it does convey any and all such privileges are not to be explained away nor curtailed by any arbitrary interpretation. It would be contrary to both the letter and spirit of the constitution to deprive the Society of the right to elect an Associate as Secretary, or President, for that matter, should it see fit to do so.

UNDERGROUND New York is represented by the following material buried beneath its 359 miles of paved streets: About 10 miles of traction cable for street-car service; 435 miles of sewers; 5,220 receiving basins; 675 miles of water mains; 1,220 miles of gas mains; 115 miles of electric subways; 3.12 miles of pneumatic tubes; 3 miles of salt-water mains; 1½ miles of oil pipe and about ½ mile of refrigerating pipes. This list, taken from The *Sun* of Nov. 2, does not include the troublesome steam-heating plant, nor the many thousands of stops, gates and manhole openings necessary in the streets to operate the net work of pipes and conduits enumerated. The list is especially interesting when taken in connection with the exhibits in our last issue, showing what this tangle now means in certain localities.

The Commissioner of Public Works has accomplished much, in a negative way, by insisting upon the completion of all underground work before the new pavements are laid and in limiting, as much as possible, the number of such subterranean pipes and conduits. But while this may do for a time it is not of permanent value, as a new gas company, for example, may come at any time armed with power from Albany, to tear up the new pavement; the city aldermen may grant new vault-permits beyond the curb-line and there is no telling what corporations may next appear with a scheme for burying mains for compressed air or high-pressure water for power, fuel-gas, or something of that sort.

The people of New York will soon, despite all questions of political advisability or of cost, be compelled to face the problem of providing some channel, independent of the street surface and street traffic, for the disposal of this material. The day is close at hand when, for its main arteries of travel, at least, New York must practically have two streets, one over the other; one devoted to the uses of citizens and their commerce, and another one, entirely distinct, in which to handle the pipe plant that is just as essential to the comfort and



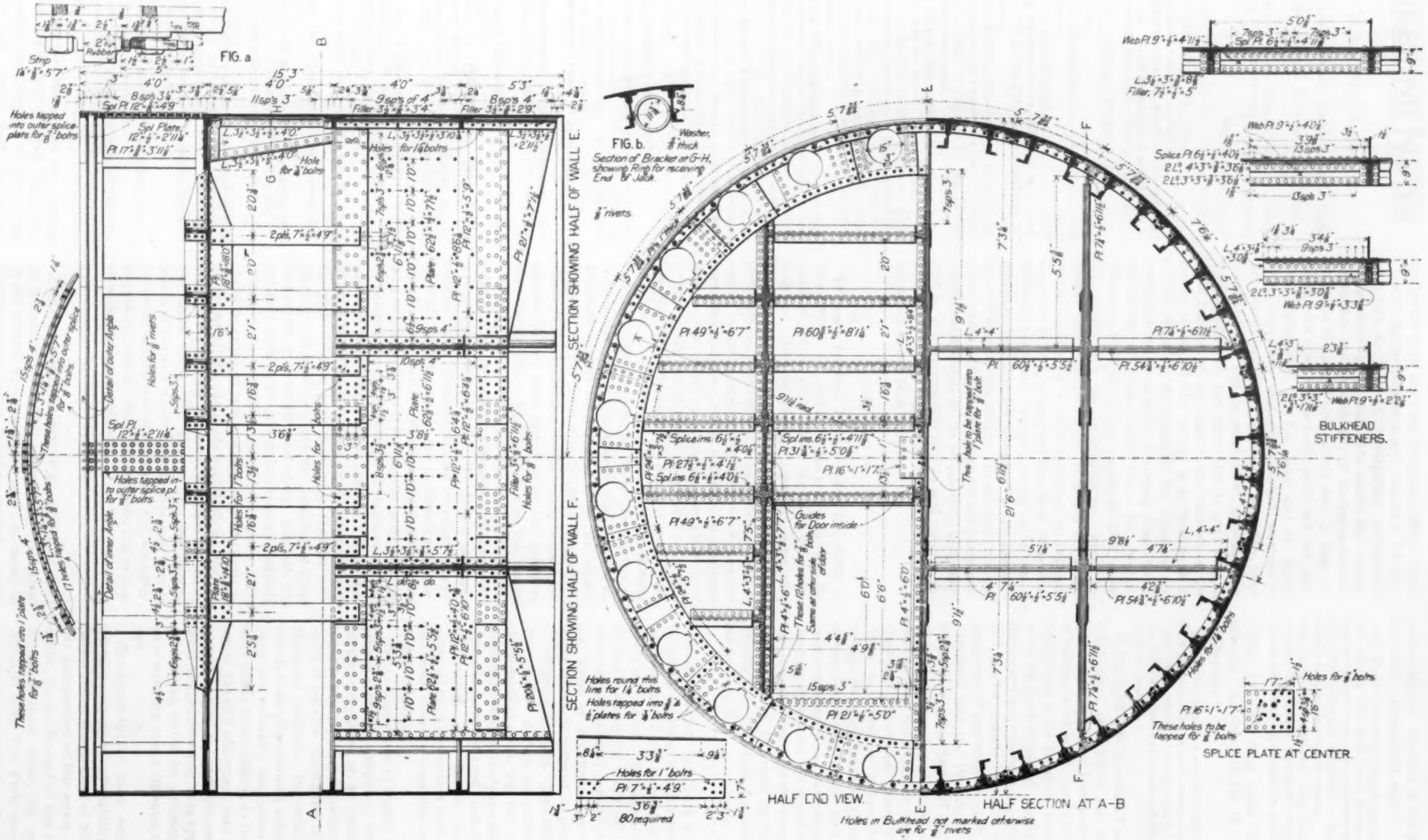
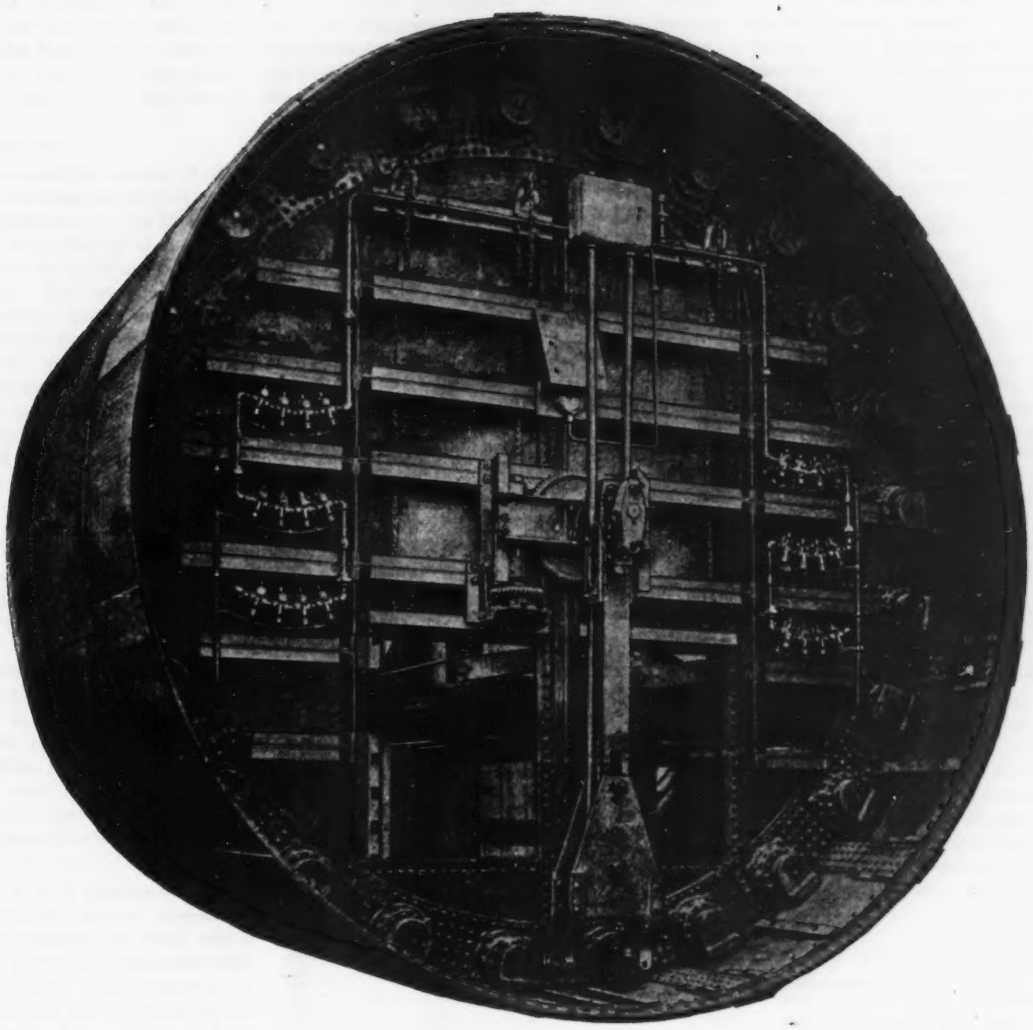


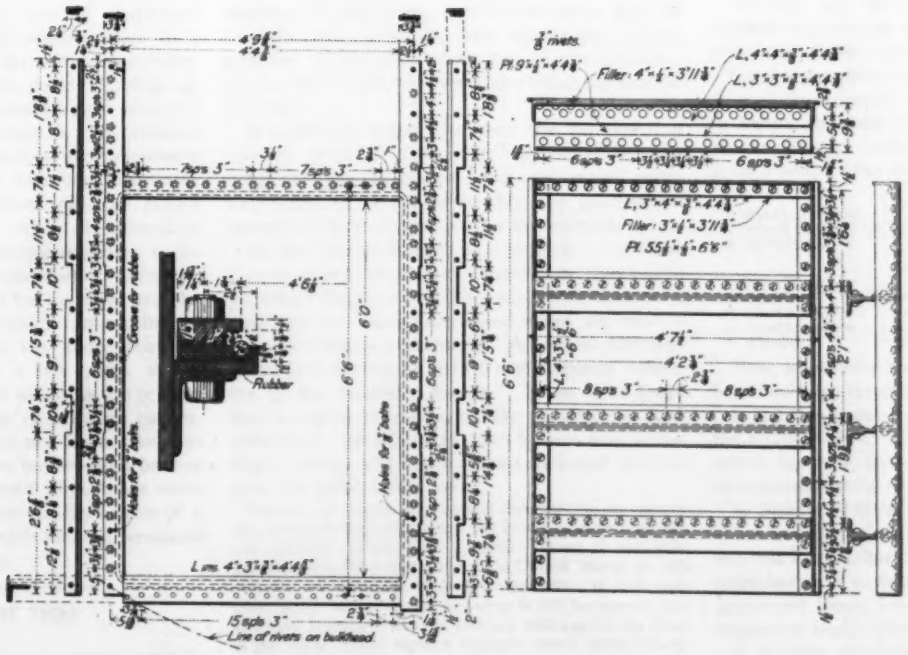
FIG. a
FIG. b.
Section of Bracket at G-H, showing Pins for receiving End of Jack
SECTION SHOWING HALF OF WALL E.
SECTION SHOWING HALF OF WALL F.
HALF END VIEW.
HALF SECTION AT A-B
BULKHEAD STIFFENERS.
SPLICE PLATE AT CENTER.
Holes in Bulkhead not marked otherwise are for ⅞" rivets

LONGITUDINAL AND TRANSVERSE SECTIONS AND HALF END ELEVATION OF SHIELD FOR THE ST. CLAIR TUNNEL.



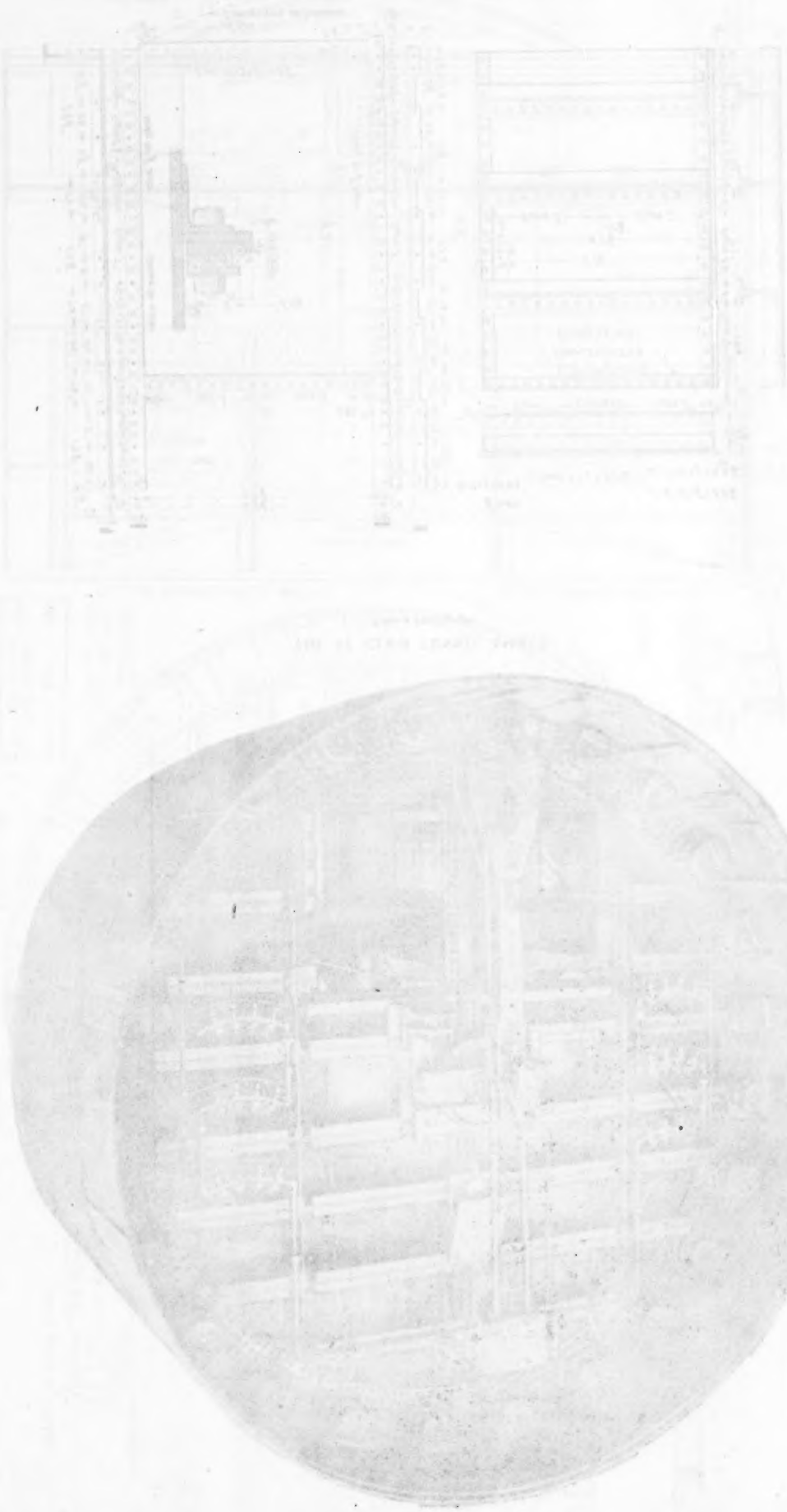
THE ST. CLAIR TUNNEL SHIELD.

From a Photograph.



Frame for Water-tight Door. Water-tight Door.

THE ST. CLAIR TUNNEL SHIELD.



material well-being of citizens. This plan "comes high," but we must have it in time, on Broadway, the Bowery and Sixth Ave., to say the least; by temporizing we are only postponing the evil day and making more costly the future solution of the problem.

FROM the description in another column of the process of aluminum production by electrolysis in use by the Pittsburg Reduction Co., an idea may be formed as to the cost of production of the metal when the process is carried on in the most efficient and economical manner. The materials which must be consumed to produce one pound of aluminum are approximately one pound of carbon, costing about 3 cts. per pound, and two pounds of prepared bauxite, costing 5 cts. per pound. To extract the metal from the ore about 23 electrical HP. is required for one hour. This probably requires about 28 indicated HP. for one hour. Taking the cost of steam power in Pittsburg as $35 per HP. per year, the cost of the power required per pound of aluminum would be about 11 cts. The cost of the labor at present employed is probably between 5 cts. and 10 cts. per pound of product, but it could certainly be reduced to or below the latter figure in operating a very large plant.

Aside from the engines and boilers, the only part of the plant which is at all expensive is the dynamos, which have to be specially made; and while their depreciation may be small, their first cost is very large. The cost of these and of real estate, with the many other necessary expenses attendent upon the establishment of a new industry, we will not attempt to estimate.

THE point which is of most interest is that the expenses necessarily involved in the process are very small. The improvements in detail which are reasonably certain to be made will reduce the present expense very largely. The greatest gains are to be expected from the use of cheap power, cheap ore and cheap carbon. As regards the first, by the choice of a suitable site, where cheap water power could be secured, its cost ought to be reduced as low as $10 per HP. per year, or about 3 cts. per lb. of aluminum produced. By developing American deposits of bauxite, the cost of the ore ought to be reduced, say, to 5 cts. per lb. of aluminum produced, and possibly by the use of improved methods of purification and concentration to a much lower figure. As for the carbon electrodes, it may yet be possible to use wood charcoal or some similar cheap and reasonably pure material whose cost will be almost nominal. No attempt has yet been made to use labor-saving machinery about the reducing pots and remelting furnaces, but when this is done the labor cost per pound should also fall to one or two cents per pound, or even less. The only remaining expenses to be considered are the interest, taxes, etc., upon the considerable capital required for the plant and the cost of its maintenance. Without attempting to estimate these, it seems from the above that we may reasonably expect in a few years to see aluminum produced at a cost as low as the present price of tin, and possibly as cheaply as copper. Much lower than this it does not seem likely to go, so far as can now be seen, nor would a further reduction be of any economic importance compared with the reduction from the high price of a few months ago to prices which make it available for countless uses in the arts.

The Census of 1890.

One of two conclusions of great moment must be acccepted in regard to the census returns just published. Either a social change of quite unprecedented suddenness and importance has taken place in this country, or the census just taken is gravely defective, not at one or two points only, but quite generally throughout the country. In the effort to determine which horn of this dilemma must be accepted we have, with no small labor, made an analysis which is in part subjoined of all the successive censuses since the first one of 1790.

We are unable to resist the force of the evidence that the main cause for this apparently startling change lies in serious and widely distributed errors of omission in the census, and this at least is quite certain, that the arguments advanced in the 12th Census Bulletin in defence of the unexpected results announced, are in large degree transparently unsound; indicating either great carelessness in studying the facts of record, or a disingenuous attempt at special pleading which will justly react to create or intensify distrust.

The pith of the difficulty lies in this: Whereas all past ratios of growth had led to the confident expectation that the census of 1890 would show a population somewhere between 65 and 66 millions, the actual population returned by the census is only 62.48 millions, a falling off of about 3 millions, or of nearly 20 per cent. in the expected increase of upwards of 15 millions, and this in the face of the fact that the immigration during the last decade has been far in excess of all precedent, in fact, nearly double the largest ever reported in any previous decade. The main facts as to all previous censuses of the entire country, taking the official records as they stand, may be thus tabulated, the war decade being enclosed between rules:

POPULATION AT EACH CENSUS OF THE UNITED STATES.

Census.	Population in *thousands.*	Per cent. increase.	Immigrat'n in decade *thousands*	Per cent. incr. less im'igra'n.
1890	62,481	24.57	5,247	14.11
1880	50,156	30.08	2,812	22.81
1870	38,558	22.65	2,328	15.22
1860	31,443	35.58	2,665	24.09
1850	23,192	35.87	1,020	26.38
1840	17,069	32.67	554	28.44
1830	12,866	33.55	137	32.13
1820	9,633	33.07	No	(32.5)
1810	7,240	36.38	rec-	(36.0)
1800	5,308	35.10	ords.	(35.0)
1790	3,929	....	....	....

The last column of this table is deduced on the basis suggested in the last Census Bulletin, which seems to be not far from correct: that in any decade the births to emigrants arriving in that decade will just about balance the deaths and returns of emigrants, so that the gross total of arrivals will represent very closely the actual addition to the population due to the immigration of the decade, the remainder being the natural increase.

It should be noted also that the immigration records prior to 1840 were very defective, and could the true aggregates be known, would probably diminish very considerably the percentages shown in the lower part of the last column.

As the Census Bulletin well remarks: "If these figures were derived from correct data, they would be indeed disappointing;" but it proceeds to declare that they are "easily explained when the character of the data is understood," the whole difficulty being that the census of 1870 was "grossly defective in the Southern States." There is no doubt that it was so defective, but the question is, how defective? On this point then follows this amazingly careless and transparently unsound declaration, the italics being ours:

> There is, of course, no means of ascertaining *accurately* the extent of these omissions, *but in all probability they amounted to not less than* 1,500,000. There is *but little question* that the population of the United States in 1870 was *at least* 40,000,000, instead of 38,558,371. If this estimate of the extent of the omissions in 1870 be correct, the absolute increase between 1870 and 1880 was not far from 25 per cent. These figures compare much more reasonably with similar deductions from *the population in* 1880 *and* 1890.

Did it, or did it not, occur to the census authorities that it was quite as important to have "these figures" for 1870-'80 compare reasonably with the war decade of 1860-'70 as with the decade of 1880-'90, and that it would be as well to compare several decades instead of one only before venturing official statement of this kind? We presume not. We will now do this, however, and we shall find it to be wholly out of the question that there should have been any such error of omission as 1,500,000, and almost out of the question that the omission should have been so great as 1,000,000.

The uncorrected census figures are:

	1840.	1850.	1860	1870.	1880.	1890.
Population in *thousands.*	17,069	23,192	31,443	38,558	50,156	62,481
Per cent. increase	32.67	35.87	35.58	22.63	30.08	24.57

If we assume the suggested 40,000,000 population for 1870, we obtain:

32.67 35.87 35.58 **27.21** **25.39** 24.57

In other words, while the percentages for 1880 and 1890 do compare pretty well, as ingenuously suggested, the favorable comparison is obtained only *by throwing into the war decade*, 1860-'70, *a larger ratio of increase than in the succeeding decade.*

Let us compare these same figures with immigration deducted, as above explained,* so as to eliminate the effect of that variable, but still using the census estimate of 40,000,000 for 1870. We then have for the percentage of natural increase only in the decade ending with each census:

	1840.	1850.	1860.	1870.	1880.	1890.
Per cent. natural incr.	28.44	26.38	24.09	**19.81**	**18.36**	14.11

Here the Census Bulletin's "favorable comparison" even with the decade 1880-90 disappears, and yet it is clear that the percentage of 1880 is much too small, and that for 1870 too large, because the former should certainly be larger than for the preceding war decade.

Let us now suppose the error of the 1870 census was only 1,000,000 instead of 1,500,000, we then obtain the following percentage of decennial increase:

	1840.	1850.	1860.	1870.	1880.	1890.
Per cent total incr.	32.67	35.87	35.58	**25.81**	**29.74**	24.57
Per cent natural incr	28.44	26.38	24.09	**18.40**	**19.68**	14.11

Here the percentages bear some sort of a natural relationship to each other, but even yet the indications are strong that the addition to the 1870 population is still too large, and should be somewhat under 1,000,000, rather than over, since there hardly seems enough difference to duly account for the effects of the war.

We may see this more clearly, moreover, in another way, which, as it forms the basis of the remainder of this article, we explain at length.

For the purposes of this investigation we have divided the country into the eight groups, used in Poor's Railroad Manual and our own Water-Works Manual, instead of into the five larger groups used by the census. These groups are:

1. *South Atlantic*
2. *South Central*
3. *Southwestern*

Including all the States south of the Potomac and Ohio Rivers, Iowa and Kansas, and including Colorado and Arizona; hereafter designated collectively the SOUTHERN BELT.

4. *New England*
5. *Middle*
6. *North Central*
7. *Northwestern*
8. *Pacific*

Constituting together what is hereafter called the NORTHERN BELT in distinction from the SOUTHERN BELT, as above described.

Now, as between these two grand divisions or belts, we have three broad facts:

1. All the census errors of 1870 are confined to the Southern belt. Doubtless all the censuses had errors, but none have been detected or are alleged, of moment, except as to the Southern belt in 1870.

2. Neither of these belts gains largely from the other by emigration, but, on the whole, the Southern belt loses rather than gains. There is much interchange of population, but, on the whole, the gains and losses are nearly equal, as interstate migration tends chiefly to follow isothermal lines.

3. Foreign emigration goes almost wholly to increase the population of the Northern belt. The part which goes south is nearly, if not quite, bal-

*This percentage of natural increase is obtained by dividing the *total* population at the beginning of a decade into the population at the end, less the immigration of the decade.